Turing's cyberworld of timelessly copulating bit-strings

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Table of contents

Abstract

The idea of the Universal Turing Machine serves as a blue-print for the basic unit of today's artificial cyberworld. Its way of working therefore also serves as a guide to investigating the spatiality and temporality of this artificial dimension to which humanity is today more than willingly exposed. In particular, an investigation of the Turing machine's linear, logically causal 'temporality' shows up a contrast with the three-dimensional, 'ecstatic' temporality of the world shared by human beings. Properly speaking, a Turing machine is a contraption for copulating bit-strings timelessly. The question concerning time, however, is the Achilles' heel of modern scientific ways of thinking and their associated intricate tangle of interminable 'isms' in analytic philosophy. Only by virtue of being nested in the existential world of human beings is the cyberworld in time. Finally, light can be cast on the doctrine of computationalism in the philosophy of mind.

Posterorum negotium ago.
Seneca, 8th *Epistula ad Lucilium*

Turing's cyberworld of timelessly copulating bit-strings[1]

[1] Many thanks to Rafael Capurro and Astrid Nettling for insightful comments. Beware: these are thoughts to ruin your career. Written for *Information* Vol. 3 2012, a planned special issue on Angeletics, and rejected by peer review. After many months access was given on 10-Sep-2012 to written comments by one of the referees, who wrote: "The author of the paper under current review attempts to criticize the poverty of the notion called time employed for practicing modern science in general and contemporary computer science in particular. Although the present reviewer is somewhat sympathetic to the author's criticism on the prevailing one-dimensional linear time, the paper would require further qualifications for justifying its own critical stance. A few comments will be in order:
1) The most important factor for the practice of computer science is the Church-Turing thesis stating that all of the universal digital machines are equivalent in mapping a natural number to other natural number. Computation is a scheme of completing such a one-to-one mapping as utilizing a finite set of elementary arithmetic operations recursively. Computability is associated with the qualification such that the computation can eventually halt in finite steps. *There is no room for being bothered by the notorious issue of time within the accepted computational paradigm.* [my italics - notice the "timelessly" in the article's title! ME] The author's criticism on the poverty of one-dimensional linear time looks like taking the trouble to set up a scarecrow to be beaten. The issue of linear time employed for computation is no more than a technical matter, though which cannot easily be dismissed. This form of muddling the fundamental issue with a technical one may weaken the message the author tries to convey.
2) The actual implication of time entertained in mainstream empirical-experimental sciences is *enormously rich* [my italics ME] as being contrary to the charge made by the author. Any scientific paper reporting new experimental findings is extremely exquisite in specifying the Materials and Methods that have been employed for the intended experiments. The linguistic specification adopted for the Materials and Methods section is performative in the sense that the experimentalist as an agency is clearly identified there, while the linguistic style employed for explicating

1. Turing's (in)calculable cyberworld

Alan Turing didn't live to see it, but he is one of the immediate fore-casters of today's artificial cyberworld, whose one hundredth birthday anniversary is being commemorated this year. More distant fore-casters of this now global technical marvel include Leibniz and Descartes, Aristotle, Plato and Pythagoras. The fascination with the possibility that the world[2] could somehow, in its deepest ontological structure, be based on number has a distinctly Greek ancestry. Now we have managed to actually make an artificial world inhabited entirely by numbers that owe their existence to the laws of electromagnetism, a progeny of mathematical physics associated in particular with the name of James Clark Maxwell. Electrical and electronics engineers have built a global electromagnetic network in which digital numbers, i.e. strings of binary digits, circulate.

Conclusions section is declarative as allowing the descriptive author to recede behind the scene even as keeping its own anonymity. The linguistic temporality markedly differs between the performative and the declarative discourses. The author remains indifferent to such a distinction as dismissing the temporality unique to the performative utterance.
3) The distinction between the past, present and future is by no means a monopoly of our fellow human beings. *Even the most primitive photosynthetic bacteria* called cyanobacteria appeared more than 3.5 billion years ago could experience daylight today, *memorize* daylight yesterday, and *anticipate* daylight tomorrow [my italics ME]. The author's charge on the poverty of the one-dimensional linear time does not apply (?) to modern empirical science, while the charge looks legitimate to modern theoretical science that still remains to be tested empirically or experimentally.
4) The paper remains ambivalent with regard to whether its theme is scientific or philosophical. If both are mixed together, the outcome would be disadvantageous to either of the two. If the theme is scientific, the question of what is the major positive statement the author would like to come up with is not settled. If the theme is philosophical, the question of what is the main message from the author other than the critical appraisal of the Heideggerian temporality also remains to be settled." In short, this referee doesn't twig.

2 Or, what is the same thing: the mind; cf. [1].

Here, cyberworld is supposed to signify more than an artificial, engineered network known as the internet, namely, an artificial *dimension* in which, or through (*dia*) whose medium, we human beings *exist* in an historically hitherto unknown way. A certain historical trajectory has attained its consummation with numbers themselves inhabiting their own artificial, physical realm, and we humans, mostly unknowingly, have intimate relations with them. Although numbers have always been written down and thus achieved a physical presence in a matrix such as paper which could always been taken up again and read, the digital numbers circulating in the dimension of the cyberworld do not always patiently wait for us to read them as such, but unfold their effects independently of our immediate involvement. And these effects are anything but merely numeric, like those of the abacus or the trusty pocket calculator. For an electrical engineer or a computer scientist, the cyberworld, comprising not just the internet, but the entire, global, more or less well-connected, patched network of digital devices of all kinds, is populated by strings of digital bits energized by electromagnetic fields and electric currents.

For the rest of us, however, these denizens of the cyberworld assume guises as little messages, entire books, photos, movies, games, etc., etc. They look quite homely and familiar because the computer scientists have worked hard to make them look and sound that way. We users of digital devices interfaced with the cyberworld need know nothing of what enables the familiar, recognizable, ‘as-if’ entities we encounter there everyday, such as news articles or interesting digitized broadcasts or a new song. Nevertheless, all these familiar entities have been dissolved into bit-strings that are kept alive in their own, special, artificial, electromagnetic matrix, whether it be, say, the hard disk in a server or a little electromagnetic stick or a small disk.

So, how did this digital dissolution of entities come about? By testing and coming up against the limits of logic in the sense of showing what can and cannot be computed by a stepwise *mechanical* procedure. This was Alan Turing’s forte and unique contribution. Already 150 years earlier, Leibniz had dreamt of a “Machina Panepistemonica” for a combinatorial calculus of justice.[3] Turing was more modest, and negative. He demonstrated in his famous 1936 paper [3] that there are

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[3] "Qvaemadmodum ergo nos hoc Panarithmonicon DEI munere invenimus, ita pro Machina Panepistemonica has Artis combinatoriae Tabulas paramus..." (Thus, just as with God's help we discover this pan-arithmetic, so we prepare these tables of a combinatorial art for an all-knowing machine...) [2]. Leibniz occupies himself with this all-calculating combinatorial art of justice in his "Science of Justice" (*Zur Wissenschaft vom Gerechten* 2nd half of 1671?), whose tables and theorems do indeed attempt to present a deductive logic of justice in which the segments of statements about justice are varied combinatorially and linked syllogistically to generate new statements of what is just and unjust. Its first axiom is "*Iustitia* est habitus amandi omnes." (*Justice* is the habit of loving everybody. [2] p. 244) Leibniz hoped that with his combinatorial science of justice a great deal of strife among humans could be settled through arriving at verdicts mechanically in a way that would satisfy any rational, reasonable mind. Turing undecidability is pertinent here insofar as it demonstrates that there are algorithms and digital input that do not 'compute', i.e. the Turing machine does not come to the 'decision' of a final bit-string output, but goes on senselessly forever. The analagous situation in the case of justice is that the justice-computing machine would be presented with a case (the input) which none of its programmed algorithms could decide, i.e. generate a verdict on. Whether the situation input was a case of justice or injustice, of right or wrong, is beyond the powers of the machine to compute. There is a similarity here to the justice machine in Franz Kafka's story, *In the Penal Colony*, which has the task not of reaching a verdict, but of executing it on the convicted. The sentence is always capital punishment, and the machine executes the convicted prisoner over a period of about twelve hours by slowly inscribing the verdict over and over with the harrow's needles on the convicted man's naked back. Death through a harrowing experience with a gruesome machine. A paper program is inserted in the upper part of the machine that controls the movements of the harrow suspended below so that it inscribes precisely the appropriate verdict, such as "Honour your superior". Through a change in the fortunes of the officer in charge of the justice machine, who sees he is losing the power struggle with the colony's new commandant over the grim 'virtues' of the justice machine, at the end of the story, this officer allows the machine to execute the capital verdict, "Be just", on himself. This self-reflexivity of the justice machine to execute the verdict, "Be just", on the officer himself who is in charge of it, sets it into a self-destructive loop. Instead of working step by step through the

formulae in functional calculus whose provability or non-provability cannot be decided by a machine working stepwise through an algorithm.

On the positive side, however, Turing constructed in mathematical detail his Universal Turing Machine that serves as a blue-print for programmable computers of all kinds that is still used in today's computer science theory. Any particular Turing machine computes, binary digit for binary digit (i.e. bit for bit), a finite binary number (bit-string) input into it literally bit by bit on the basis of a finite set of instructions (the program code) that, depending on which bit is being scanned at the current step, instructs the machine what to calculate (i.e. change the bit or leave it as it is), whether to move one space to the right or left (or stay where it is) on its linear memory-tape, and which instruction comes next. The set of instructions (also called a routine or algorithm) itself can also be coded in bit-strings and input into the machine at the start, resulting thus in the Universal Turing Machine which is capable of computing any number at all that can be computed.[4] The finite set of instructions uniquely defines a particular Turing machine, and this set of instructions can be coded into a unique natural number. It turns out that this relatively crude and simple bit-crunching machine can calculate any calculable number at all, i.e. that more sophisticated machines with more complex movements and parts, but still working algorithmically, cannot do any better than a Turing machine, although they may be more efficient in terms of the number of algorithmic steps required to reach a result.

The Universal Turing Machine is a copulating machine that has one bit-string, the program code, copulate with another bit-string, the digital data-input, to generate a further bit-string as output. In general, the program code is the 'male', active, executable code, whereas the digital

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lethal execution process, it goes haywire, slowly falling apart bit by bit and quickly stabbing the officer with its needles, leaving his corpse suspended in the air instead of depositing it in a ditch next to the machine, as usual. The mechanical execution of justice thus destroys itself in enacting the verdict of justice itself. Justice cannot compute itself.

4 For a lucid presentation of the Universal Turing Machine in terms of pure bit-strings, cf. [4].

data-input is the 'female', passive bit-string that suffers itself to be computed to generate a bit-string. But the data-input and data-output can contain also sections of executable code such as macros or so-called computer viruses, trojans and worms. The cyberworld is driven by myriads of Universal Turing Machines, each equipped with its own program code and ready to compute digital data input into it, thus generating yet more bit-string output that circulates on further in the digital electromagnetic matrix. The engineering problem for the cyberworld is how to build networks that enable the efficient, error-free computing copulation of bit-strings with each other and their efficient, error-free transmission through the cybermatrix to their next destination. To solve this problem, electrical and electronic engineering relies on the physical sciences that provide the basic laws of motion of electrons (electricity) in a constructed, controlled electromagnetic medium that serves as the matrix for bits to be 'implanted', embedded. Shannon's theory of 'communication' [5] is concerned primarily with the error-free transmission of encoded digital (and, secondarily, analogue) 'message' without regard to its message-content, and is thus aimed at a mathematical solution to an engineering problem.

However, bit-strings *signify* something. The Universal Turing Machine is not merely a toy for copulating bit-strings with each other to procreate new bit-strings, and the cyberworld is not merely the plaything for engineers through which to transform arbitrary bit-strings. The cyberworld is itself embedded not just in the larger physical world, but in a meaningful human world that is both spatial and temporal. Hence the cyberworld has its interfaces with the physical world which, in turn, is an aspect of the human world. The interfaces themselves are both physical and computable.

An example of an interface between the digital and the physical is a thermostat that controls the operating temperature of a boiler or furnace by allowing temperature data to be gathered and permeate through it. An example of a computable interface is the transformation of bit-strings into wave-frequencies for the colours of a screen for presenting the bit-strings to a human viewer in a human-legible form. Such a presentation is *physically present* to the human viewer's *sense organs* (the eyes in this case), and the problem of the interface between the cyberworld and the human user is conceived invariably as one of the physical presentation of meaningful information to the sense organs of a human viewer who, it is supposed, makes sense of this presentation. It is only a human observer who can see information *as* information. This *as* is the hermeneutic *as*, and human being itself is *hermeneutic* through and through. Thus, for instance, a certain visual pattern on the screen is interpreted as a word in a certain language and understood (or not, i.e. understood *as* incomprehensible to that viewer), or it may be interpreted *as* an image of *something*. (It is not trivial that a human being can see something *as* something, and modern science invariably begs this question.)

The output-interface, ultimately with a human being who understands its world in a certain way, of course, is complemented by the input-interface and also by the human writing of executable bit-string code, which consists of impressing bits into the electromagnetic matrix. The input-interface may throughput physical data such as traffic-flow on a certain road or the light waves reflected from an object (photography), or it may digitize human writing of some kind signifying something or other. All these are regarded in information science as information, but it is advisable to make a distinction between brute physical *signals* and meaningful inscriptions or *messages*. The latter are a setting-down in some sort of *writing* what a human being *understands* about something or other, whereas the former, say, the capturing of temperature signals that are passed on, presupposes a human understanding that has been able to construct a device susceptible to ambient temperature at some location (perhaps on a spaceship in outer space) that transmits a precise physical signal to another device *predesigned* to 'interpret' the signal as a temperature of so-and-so many degrees, registered by a definite number. Such signals have always been predesigned by some human understanding (that of a physicist, an engineer, etc.) and so are always already *interpreted* in a certain way, that is, these signals are not nakedly physical, but always already filtered by (technical) human understanding.

Hence the physical transmission of signals within the cyberworld and through its interfaces with the surrounding physical world, is, in one sense, purely physical and proceeds of itself, but, on the other hand, all these physical signals have been set up from the outset within a framework of (technical) human understanding to some purpose. Both input and output data, whether signal or message, are therefore always already interpreted and understood in some way. Hence any physical *signal* is always also implicitly a *message* because it has always already been understood *as* such-and-such. This hermeneutic *as* is taken for granted unquestioningly by modern science, that is fundamentally blind to this phenomenon. For instance, a thermometer may receive energetic signals from the ambient environment, but these signals *are* such only within a technical-scientific world-interpretation, which we may label 'Cartesian', that is relatively recent.

The same goes also for the executable bit-string code that is impressed somewhere in the cyberworld's matrix. Herein lies the astonishing achievement of Western arithmological thinking that has reached a sort of culmination with Turing's ingenious casting of his universal computing machine. Although any tool or artefact made by humans is always an embodiment of a certain segment of human understanding of the world (e.g. the humble potato peeler is cleverly *designed* to fulfil its function), executable bit-string code is a set of 'materialized', step-by-step instructions for carrying out a computation on input data, and hence an *outsourcing* of a segment of human logical understanding of a certain situation that is inscribed in the physical matrix of the cyberworld. Human logical understanding is not only inscribed in a medium, but acts there on its own.

Instead of a human being himself going through a computation step by step according to an appropriate algorithm, the algorithm itself is encoded, embedded in the electromagnetic matrix, and is then able, if all goes well (i.e. there are no bugs in the code), to *automatically* copulate with any bit-string of input data that comes its way to generate its progeny, namely, a result which, in turn, may cybernetically effect a movement/change elsewhere. The computation itself is a *movement* or *change* in bit-strings (and be it only of a single bit), which is also a *physical* movement, because each output bit must be held in its 0 or 1 state by properties of the electromagnetic medium. The digital output has to be interpreted, or rather, is invariably already pre-interpreted, by the device in which it is generated, either as a physical signal or as a meaningful sign. Thus the bit-strings are translated back into human understanding of something or other, a certain situation in a certain state, etc. *as* such-and-such. The physical signal received by a thermometer, for instance, may mean ‘too hot’ (say, for human comfort in a living room).

The change in bit-strings computed by executable code somewhere in the cyberworld is *determined* by the digitally encoded algorithm. This output may then be passed on as a signal to effect other changes, either within the cyberworld or through one of its interfaces with the surrounding physical world. The cyberworld and its effects on the environing physical world is thus set up, and works, in a causally deterministic way to bring about envisioned, precalculated changes, i.e. movements, of all kinds. This is the sense of the prefix ‘cyber-’ (from the Greek verb κυβερνᾶν ‘to steer’, ‘to govern’) in cyberworld: it is an artificial dimension set up to *control* movement and change via algorithmic control over changes in bit-strings. Thanks to the global reach of the electromagnetic matrix, it is no exaggeration to say that in some sense humanity has (seemingly) achieved global technical-scientific cybernetic rule.

To speak of humanity in this global sense, however, is already a self-conceit, because humanity is splintered into many, many human beings living on Earth. Many human beings, therefore, can bring executable code and digital data into circulation in the cyberworld whose movements can thwart and *subvert* each other. One computed bit-string output may be negated by another bit of executable code, for example. Or a packet of executable code may be smuggled in to a location in the cyberworld to take over control of or simply shut down an industrial plant. Or digital messages posted on some public site in the cyberworld may be overwritten with a contrary message. In view of the *plurality* of human actors intervening in the cyberworld, control over bit-strings and their physical and message effects is continually being subverted by hacking, viruses, trojans, etc. This opens the prospect even of *cyber-warfare*, especially because military and industrial installations (e.g. a national electricity grid) are themselves today controlled by executable code which may be infiltrated by foreign bits of program code. In this sense, the invention and construction of the cyberworld as a material realization of myriads of Universal Turing Machines have merely opened up a new, hitherto scarcely conceivable dimension for the entire gamut of all-too-human power struggles and rivalry. Such is our brave new cyberworld.

What started out as a dream of total technical control of an artificial, calculable dimension and its physical interfaces thus degenerates into a struggle among many seeking to control changes by means of executable code and message input (digital propaganda). This has everything to do with the splintering of mind into myriads of individual minds who can outsource their logical understanding of a segment of the world in order to bring about a desired change, such as the fraudulent diversion of somebody's online bank transfer to their own online account or the gathering of data on the online movements of its citizens by a state's intelligence service.

2. Spatiality of Turing's cyberworld

There are two distinct spatial perspectives on the cyberworld which can be called the engineer's and user's perspective. The engineer's perspective, from the outside, is on a physically located global network consisting of servers, routers, cables, satellites, user devices, machines and installations with digital interfaces, etc. All these technical things are located somewhere in physical space, say, in Phoenix, Arizona, or Bangalore, India or on an orbit around the Earth. *Cyberspace*, however, is the user's inside spatial perspective on the cyberworld through which the user 'sees' the cyberworld's denizens themselves, namely, the bit-strings. To 'see' inside the cyberworld requires a sensuous user-interface such as a (touch-)screen, keyboard, microphone, sound-card, etc. because users are sensuous beings who interact with the physical world in the *present* through sense organs. Hence the need for visual, tactile, audio interfaces. Locations within the cyberworld are given by a bit-string address, say, an IP-address. These numeric addresses, which are ultimately just bit-strings, are, mathematically speaking, the vectors of a vector space. The user, however, usually sees only some kind of alphanumeric address, like a street name, on a screen. At that binary digital location, the user encounters a bit-string which, however, does not present itself simply *as* a bit-string of 0s and 1s, but as some sort of visual text or visual image or audio sound. This is because the bit-string has been translated by clever executable code into a sensuous output for the user.

For the user navigating within the cyberspace of the cyberworld, the digital addresses provide *orientation*, since each address is a well-defined vector. The user can also *go to* any address simply by inputting the appropriate bit-string either directly or indirectly via some convenient interface such as a keyboard or a graphic pointing device (mouse). In this way, any cyberspace location can be easily brought into proximity, usually with a single click of the finger on a pointing device or a tap on a touch screen. These two characteristics, namely, *orientation* and *nearing*, characterize existential spatiality [6] [7]. There is no need for the user to move bodily through space from one physical location to another for there to be such a thing as cyberspace. A minimal movement of the finger, or not even that, suffices for the user to move through this digitized space, since even mathematical entities such as bit-string vectors retain an abstract kind of spatiality. Indeed, vectors are simply the arithmetization of directed geometrical intervals, and geometrical entities are attained by simple abstraction from physical bodies, retaining a certain spatiality, as Aristotle demonstrated in his *Physics*; cf. [7] §2.1.

Hence it can be seen that, despite the highly abstract, mathematical nature of Universal Turing Machines, whose multiple materialization and concatenation result today in the cyberworld populated by zillions of continually copulating bit-strings, for the user navigating and encountering these bit-strings, a kind of existential spatiality is retained. This experience of cyberspatiality can be enhanced for the user by means of well-designed, 'as-if', graphic interfaces that rely very much on geometric spatial intuition.[5] Thus, images are displayed to users that make it easy for them to know where they are in the cyberworld. These images, however, are the sensuous translation of a long bit-string which, as a dumb mathematical entity, has no 'idea' of where it is.

3. Temporality of Turing's cyberworld

Things start to get more exciting and challenging when considering the specific *temporality* of the cyberworld. This is so because today's science, and not just computer science, lacks an adequate conception of time. Indeed, everything hangs on recasting our conception of time, and that not just with respect to the cyberworld.

In early computers, the bit-string was displayed as an alphanumeric string which, of course, can always be resolved further into the underlying bit-string. There has always been a need for a sensuous translation of bit-strings back and forth because humans are incapable of reading digital code consisting of endless strings of 0s and 1s. A computer, by contrast, is *only* capable of 'reading' *successively* a string of bits; it 'sees' *only* the single bit currently before its 'eye' (electromagnetic scanning head) in the physical, sensuous *present*, but not *as* present, since it is not exposed to time-space at all. All bit-strings that *have been* are either lost (deleted) or inscribed elsewhere at some bit-string address in the matrix, perhaps with some kind of time-stamp that a programmer, who *is* exposed to time-space, has arranged to have stamped on the bit-string. The computer's scanning head may return to that location during its routine to reread a previously inscribed bit, *not* because it has a memory and can recall, but because it is instructed in the *present* to make certain mechanical moves that may end on an 'old' square of the Turing machine's memory-tape, i.e. an already used storage address. It then 'reads', i.e. physically detects, the bit written on that square in the *present*, for the scanning cannot distinguish between

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5 The issue of the discrepancy or 'gap' between the (irrational, uncountable) continuity of physical space and the (rational, countable) discreteness of cyberspace will not be gone into here; cf. [7] §2.6, [8].

past and present; everything it reads is simply physically present, but not *as* present.

By constrast, a human being can recall past events and allow them to come to presence *as* past (a kind of absence that refuses presence, or an absence that is peculiarly present), whilst simultaneously remaining also in the present, so that both past and present are present, but in two different modes. Or a human being can reread what she or he or someone else wrote down in the past, understanding it *as* a message from the past that is kept distinct from the present. The past inscription is dated in some way, either with a proper date, or more loosely as ‘back then when such-and-such was happening or after some other event’. That is, a human being can order past events and also past inscriptions within temporal space, whereas the scanning head of a Turing machine is oblivious to the temporal dimension altogether. Its scanning head only ever detects a *physically present datum*. Only indirectly, via the machine instructions, does it come to redetect past inscriptions, but only in physical presence.[6]

More broadly, one can say that Turing machines, and the cyberworld they constitute, are artificial, highly abstract, timeless mathematical entities. But the cyberworld is also a world for us who are in time. Our human being is exposure to time-space in which beings presence and absence, and our minds are witness to this spectacle. Modern thinking, however, doesn’t get this; it overlooks time and inverts the relationship between mind and cyberworld: The mind itself is conceived, i.e. ‘modelled’, *as* a kind of complicated data-processing computer in various variants of so-called computationalism (see last section). Turing himself wrote his 1936 paper as if the “computer” he was speaking of were a human mind; he modelled human thinking itself on the logical computing machine whose blue-print he lays out in detail. This is in line with the scientific prejudices of our age: to be means to be there in *physical presence*, capable of providing and taking in sensuous data. The Universal Turing Machine’s ‘mind’s eye’ is its electromagnetic scanning head with which it dumbly detects the relevant bit *presently* to enter the

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[6] Cf. the machine instruction **cp** for comparing bits in [3] § 4 p. 238.

algorithm. This corresponds to human consciousness that purportedly, at any instant, focuses on the representation generated by the brain for presentation to it in the present.

The temporal dimension of the *past*, for this modern 'computational' way of thinking, is *memory* which consists of physical data stored somewhere, somehow in the brain and which supposedly can be recalled to presence by the brain's neurological activity. So, too, does a Turing machine have many bits of data stored on its tape-memory to which it can return for rereading, given the appropriate instruction. For instance, it can be instructed to find the last bit-string identical with a bit-string just generated. It can do so only by comparing *successively*, in different instants of time, bits at different points on its tape. A Turing machine computes its given task by generating its result bit by bit according to the stepwise instructions of the algorithm, its program. By convention, this result is generated successively to the right on the tape, which is initially blank. Everything the Turing machine has already done is, by convention, written to the left of the scanning head at the end of each step, before it finds and then starts carrying out the next instruction, i.e. the computed result of printed 0s and 1s builds up successively to the right, with the scanning head printing them on the next available blank squares to the right and then copying the entire machine configuration once more at the end [9]. Before seeking out and marking the next instruction-step in the algorithm, the machine's 'mind' is at the end of all the bits it has 'written', so that they are behind it, with a blank tape in front of it. That is, its 'mind' is a blank until it assumes a 'state of mind', namely, the next consecutive instruction, which causes it logically to make certain movements to compute and print the next bits of the result.

Hence, the computing machine's 'state of mind' is the present instruction it has 'in mind' whilst 'looking at' the bit (0 or 1) it *physically* and *presently* has before its 'mind's eye' (the scanning head). Its 'past' lies behind it on the tape in the form of the bits it has so far printed, and its 'future' is an infinite string of blanks lying before it. The further steps in the algorithm will determine how this blank 'future' is filled with bits, as well as when and whether it will 'get stuck' in a circle and come to a halt. The Turing machine therefore has a completely determined, blind 'future' that unfolds stepwise by carrying out the algorithm as laid down in the program code, which itself is nothing other than a bit-string. This completely determined 'future', however, is at the same time incalculable in the sense that there is no way of calculably foreknowing in every case whether the Turing machine will come to a halt or cleanly compute a definite result (cf. the so-called 'halting problem' in connection with the Hilbertian Entscheidungsproblem [10]).

From this it can be seen that, as is the case throughout modern scientific thinking, a *conception of one-dimensional linear time* is implicitly at work in the idea of the Turing machine, whether universal or particular, whilst a Turing machine itself 'knows nothing' of time. The 'future' is a blank since the machine's 'mind' (its scanning head) only ever has 'in mind' the bit it is presently scanning. Its 'mind' is stuck in the physical present. The machine's past is not 'in mind' but stored 'out of mind' somewhere back on the memory tape as bits that can be retrieved (or 'called back to mind' or 'reminded') by entering the appropriate 'state of mind', i.e. by carrying out a machine instruction to move the scanning head to the left. The machine then moves back into its 'past' (the tape on the left) and *physically* detects the bit on a certain square in the *present*. As a machine, it is unable to 'call to mind' in *presence* whilst leaving what is called to mind (the relevant bit) in *absence* as *refused* presence.[7] Which bit this is, 0 or 1, determines what it is to do next, depending upon the program code that sets out the instructions. It may leave the bit unchanged, or change it to its opposite, and then move either one step to the left or right. Every step of the algorithm, and every move in working through an algorithmic step, is completely determined by an effective logical causality.

An effective *logical* causality, in contradistinction to an effective *physical* causality, is an inferential chain of logical marks effected by following simply-put logical instructions. Logical marks and instructions can and must be 'read'. In this case, the logical instructions are inscribed in the electromagnetic matrix, and it is a machine's

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[7] On the refusal and withholding of presence by the temporal dimensions of past and future cf. [11].

scanning head that can detect pure difference, namely, the difference between 0 and 1 which, in turn, can be interpreted as a simple absence (blank) or simple presence, 'as if' the machine were reading. The tape's linearity is a consequence of the thoroughly deterministic logical causality that rules all the Turing machines movements. (This continues to hold true even when the strict, linear determinism is softened and split up by probabilities associated with the instructions that causes a branching of machine-actions into a finite number of parallel computations.) Because with executable binary code, effective logico-inferential causality is outsourced to the electromagnetic matrix, it becomes effective physical causality.

Since the machine computes its result by working through the algorithm step by step and printing it on the blank squares to the right, its movement is a movement into a linear, blank future into which the machine's mind has no foresight whatsoever. It is blind to its future, which comes toward it with total, logically causal necessity. A Turing machine is therefore *unfree*, since freedom demands insight into the future[8] and also that the present is a swivel-point for (degrees of)

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8 On the transition from blind necessity to insightful freedom: "Im *Begriffe* hat sich daher das Reich der *Freiheit* eröffnet. ... Die Dunkelheit der im Kausalverhältnisse stehenden Substanzen füreinander ist verschwunden, denn die Ursprünglichkeit ihres Selbstbestehens ist in Gesetztsein übergegangen und dadurch zur sich selbst durchsichtigen *Klarheit* geworden; die *ursprüngliche* Sache ist dies, indem sie nur die *Ursache ihrer selbst* ist, und dies ist die *zum Begriffe befreite Substanz*." [12] (English: In the *concept*, therefore, the realm of *freedom* has opened up. ... The darkness of substances standing for each other in a causal relationship has vanished, for the originality of their existing-in-themselves has passed over into a positedness and so become *clarity* that is transparent to itself; the *originary* issue/cause/matter is such only by being the originary *cause of itself*, and this is the *substance that has been freed to become concept*.) There is a play on words here between "Ursprünglichkeit" (originality), "*ursprüngliche* Sache" (originary thing, matter or 'causa') and "*Ursache*" (cause). A substance does not yet have the origin of its own movement with itself, but is subject to the blind necessity of the causal conditions by which it finds itself bound. In positing itself as the origin of its own movement, the substance gains insight

freedom of movement, i.e. that the present is truly a non-predetermined *beginning* or *point of origin* (ἀρχή) for future movement/change that breaks with the past. Freedom demands a *rupture* in the chain of effective causality and several degrees of non-predetermined freedom for movement/change, so that the present is truly open to the future. Linear time is antithetical to any conception of freedom because it goes hand in hand with a totalization of effective causality, whether it be physical or logical. In materializing a Turing machine, the logical causality is transformed into a physical causality. A Turing machine has no *power of imagination* whatsoever. Imagination is a calling to mind in *presence* of what might be, whilst leaving what is called to mind in *absence* as *withheld* from presence.

As *physical*, any machine is tied to the present, i.e. to its present state and what is presently in contact with it (the physical data it receives); it is unable to stretch itself into the two distinct kinds of absence, the past and future, and cope with the ambiguity of presence and absence 'simultaneously', as a human mind can do and constantly does (even though modern science 'thinks nothing' of it). What has been and what might be can present themselves to the human mind without relinquishing their absence. A Turing machine, by contrast, is entirely unable to imagine its future but can only move step by computable step into its future by computing the successive steps of its algorithm. Likewise, it is able to refer back to its past by moving back along its 'memory'-tape, relinquishing however its presence, i.e. it can only shuttle back and forth because it is unable to bear the ambiguity of *both* presence *and* absence.

A Turing machine is conceived in line with the traditional metaphysical (Aristotelean) casting of time as a succession of now-instants proceeding linearly from the non-existent (not yet) future into the non-existent (no longer) past. Its 'mind' 'sees' only a physically present bit, and its algorithm instructs it to *move* from one square to another, reading *successively* the bits on the square and sometimes

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into its future movements and so can determine its own future. Thus it becomes "concept", i.e. subject.

changing them. To do this, a Turing machine needs a *duration of time* and also the *power* to drive its movements. Computation time and energy are thus major issues when building a Turing machine. Since encryption codes themselves can be cracked eventually by computation, computation time becomes a practical issue for cryptography; and the practicability of algorithms that compute in principle, but may take an inordinate amount of time, is the major issue in complexity theory [13]. With the rise of the cyberworld, the focus on the issue of the energy supply for technologically controlled physical movements shifts somewhat from that of transportation and electrical appliances, machines and installation, to the energy that needs to be generated to power the movements of the cyberworld. A human mind, by contrast, doesn't require such high physical energy inputs for its cogitations.

4. The cyberworld nested within the world

So, what does all this have to do with the cyberworld as that artificial dimension of myriads of materialized Universal Turing Machines enabling the copulating of zillions of bit-strings of program code with zillions of bit-strings of digital data? As a concatenation of Turing machines, the cyberworld is both entirely calculable and also incalculable. It is calculable insofar as each Turing machine simply dumbly carries out its programmed algorithm step by step in an entirely deterministic manner. After all, each Turing machine is a calculating machine and it has been programmed and tested to achieve a certain useful result in human terms. On the other hand, however, and as mentioned above, the intermeshing of huge numbers of Turing machines, each with its program code, can lead to incalculable results insofar as program code can be written by human beings and introduced into the cyberworld to throw a spanner in the works by subverting, undermining, countermanding the operation of other program code. This is, so to speak, the technical, computer scientist's view of the cyberworld in its inner operations.

The cyberworld, however, is itself nested within the world in which human beings exist. In its deepest ontological structure, this world is time-space, for to *be* human means to be stretched 'ec-statically' into the three temporal dimensions of past, present and future. Human being itself is existence, or ec-sistence, which means literally ‘standing-out’ in the world in its three-dimensional, temporally ec-static structure. Such three-dimensional ecstasy cannot be captured by any linear conception of time, as scientists are hell-bent on doing. In particular, ec-static human ec-sistence is able to bear the ambiguity of ‘simultaneous’ presence and absence, which a physical machine cannot. ‘Simultaneity’ gains an entirely new meaning in the context of three-dimensional time. A human mind comprises more, and sees more, than any physical machine, which is blindly tied to the physical present at the end of a chain of effective causality, as we have seen above with respect to the Turing machine. The temporality of the cyberworld is therefore derivative of its being embedded in the world shared by human beings existing in time-space. Human being and time-space (i.e. the 3D temporal clearing) eventuate together, for they need each other.

Under the impact of the tremendous successes of the mathematical physical sciences since the seventeenth century with its way of thinking that today has infiltrated and infected all thinking, including especially philosophical thinking, it has become an unquestioned, self-evident, purported ‘fact’ that only what is physically present truly ‘is’. This is supposed to hold true for the human mind as well. Hence, it is supposed that the human mind can be involved with what is presently before the mind’s eye, that is, with what is *physically present* for it to sensuously take in through its *sense organs*. Otherwise, the human mind is supposed to be pre-occupied with what is ‘inside’ ‘in its head’, i.e. with physically present *re-presentations* of what has been or of what might be. One therefore distinguishes confidently and dogmatically between the outside world and inside the mind. The representations in consciousness are supposed to be *present* somewhere in the mind that somehow or other is identified with the *physical* brain with its ‘infinitely’ complex web of firing neurons. How could such a physical brain, an intricate hunk of meat, ‘represent’ the temporal dimensions of past and future, since everything *physical* is there simply in the present?

If entities are merely represented ‘inside’, ‘in the head’, they supposedly don’t ‘really’ exist at all, but only as ‘subjective’, ‘interior’ figments which are purportedly at most 'useful illusions'. But perhaps it is the scientific way of thinking with its scientific method that is the illusion. We human beings have been suffering under this illusion of inside and outside for millennia, and it has only become worse with the rise of the modern physical sciences. For millennia it has been implicitly and, ultimately, dogmatically assumed that 'to be' means 'to be physically present', thus truncating the sense of being to a stump of palpable presence. The other dimensions of time are supposed not to 'exist'.

For almost a century now, since the publication of Heidegger's *Being and Time*, there has been a philosophical alternative enabling a break with this unbudging blinkeredness. Instead there is only evasion of the question, and its suppression by any above-board or under-the-belt means available. An hegemonic way of thinking is fighting, with all its institutionalized power, to retain its supremacy by insisting on the unquestionableness of its fundamental 'scientific' prejudice with respect to the very meaning of being.

With any luck, unseating an old, deep-seated prejudice and lifting the veil from an ancient illusion should allow us to see better how the cyberworld is embedded in the world inhabited by human beings. It is namely human beings who write the program code and provide the digital data that enter the cyberworld through some kind of interface. Even the collection of physical digital data is first set up by a human being installing the appropriate device, such as a thermometer or a pressure gauge, and connecting it through an interface with the cyberworld with its population of myriadfold bit-strings. Human beings are concerned with and caught up in their own life-movements and hence are also concerned with the movements and changes of all that surrounds them in the world. All the events in the world, for instance, are kinds of changes that may impinge on human lives, including of course newsworthy events, so that human beings take notice of them. Or we human beings are concerned with productively controlling movements with a particular end in sight, say, when going on a journey or saving enough for retirement. We are exposed to a world of change on both the micro- and macro-scales, and we also make changes that we aim at controlling for specific good ends we envisage, taking account of the given situation we are in at our starting-point.

The cyberworld comes in here *firstly* as a medium for sending and receiving intelligible messages of all kinds which may be in written, image or audio form. Any kind of message can be encoded as a bit-string and submitted to the appropriate Turing machine that will automatically send it on its way through the cyberworld, from one Turing machine to the next, until it finally reaches its destination(s). Postal, telephone, newspaper, radio, television networks of the old kind can therefore easily be digitized by writing the appropriate program code for the appropriate Turing machine and inserting it physically into the cyberworld through the appropriate interface onto a server where it does its intended work automatically. Entire sites in the cyberworld can be dedicated to the exchange of messages on all levels among a few or millions of users. All this is achieved by copulating executable program bit-strings with digitized messages in numerous Turing machines in order finally to get the message across to the intended recipient(s). The cyberworld thus facilitates the communication of messages in ways, including surprising ones, to which we are still adapting today.

These new ways change also all kinds of social and political *power struggles* [14] because the cyberworld enables on a hitherto inconceivable scale and with hitherto inconceivable ease multitudes and multitudes of people to get their messages across to each other. In this way, centralized political control and centralized social control (e.g. through influential, opinion-making public media and publishers) are subverted because all social and political power rests ultimately on its being *recognized*, and thus *validated*, by those subjecting themselves to it. Messages signifying non-submission to powers that be contest that power at its core.

Secondly, however, the cyberworld serves as a medium for effecting changes both within itself and, via interfaces, in the physical world. For instance, executable program code can be written to automatically update the data in an electronic databank located somewhere in the cyberworld. These data may then be called up by another Turing machine to compute results that are eventually delivered to human readers. Or executable program code can be written to monitor and control via digitized signals the movements of some machine in the physical world, such as a satellite's orbit or an automobile's route or the impulse-rate of an artificial pace-maker inserted in a human chest.

Humans can do such things because they are able to *imagine* what might be, but is not present, and also undertake *productive* steps to allow what is imagined to come to presence. They must therefore be capable of *'double vision'* in the sense that they can see what is present and also what is absent and withheld from presence, i.e. they can bring to presence in the mind's eye what is absent, and thus envisage future movements and changes pertaining to their *present* existence in the world. Such double temporal vision is impossible for a machine because it is not exposed to three-dimensional time-space.

The two above-mentioned different kinds of ways in which the cyberworld serves to get messages across, on the one hand, and to effect productive changes, on the other, also *intermesh,* working hand in glove, in the important sense that digitized productive techniques embodied in clever executable code serve also to disseminate messages and attract an audience to them. So far, so good. It seems at first that the cyberworld is a mightily useful tool for humanity to improve the lives of people on a global scale. However, at the latest since Marx, the thought of the inversion of human users of tools into mere appendages of a machine has become familiar, and there are signs of such an inversion today when users become 'addicted' to their digital devices and 'controlled' by messages received out of the cyberworld.

This issue will be left aside here in favour of focusing on another phenomenon, namely that, because there is a multitude of people each employing productive techniques, these multiple efforts may enter into a contest with each other, a *power struggle*. Each human being is the point of origin for its own life-movements and hence a *source of power* (δύναμις) in the originary sense of being a point of origin for change/movement, as worked out by Aristotle in Book Theta of his *Metaphysics*. A multiplicity of power-sources inevitably enters into a *power play* with each other, which may be aligned for, against or with one another. The invention of the cyberworld therefore extends the field within which also human power struggles are played out *against* each other and also introduces new weapons of power struggle. A power play *with* each other is what we usually call co-operation, collaboration or teamwork, and the cyberworld opens up ‘countless’ new possibilities for collaboration. A power play *for* each other is a mutually beneficial exchange in which each individual exercises its powers for the benefit of the other, as in market exchanges.

One kind of power play for, with and against each other is modern *economic life* in which each of us earns a living by earning income. This will be taken as exemplary for how the cyberworld intermeshes with world. In this modern age, economic life goes on as the augmentative movement of *reified value* mediated by value-things, otherwise known as *capitalism*. Everybody is engaged in the *gainful game*, which is the name for the socio-ontological structure of modern economic life [15] [16]. Because of its essential mathematical abstractness, the cyberworld dovetails beautifully with the gainful game insofar as the efficient, automated movement of bit-strings can enhance the productivity of all sorts of capitalist production and circulation processes in manifold ways, as well as accelerating the turnover-time of capital [17], which, on its essential level, is nothing other than the abstract, augmentative, circular movement of reified value from advanced money-form through value-forms of productive and circulation processes back to money-form, ‘ideally’ augmented by a portion of surplus value.

Apart from this, the cyberworld, serving as a congregation place for millions and millions of users, can also be converted into a *market-place* for commerce in commodities of all kinds: e-commerce mediated by the exchange of bit-strings. Because all movements in the cyberworld leave a trace in the stored bit-strings they leave behind, these bit-strings stored in the global electromagnetic matrix, which corresponds to the tapes of myriadfold Turing machines, serve not only to record transactions and their details, to perform monetary transactions via online banks, but also to gather digital data on the movements of online consumers. Each consumer is identified with a digital identity that starts with a user name, password, digitized bank account number, and proceeds to digital traces of detailed movements in the cybersphere that provide clues as to each consumer's purchasing behaviour. This is a boon for marketing and advertising, which has always been an important auxiliary to mercantile efforts. They have become increasingly sophisticated during the twentieth century with the rise of modern means of transportation and telecommunications that have enabled the phenomenon of mass markets that can be worked over by marketing departments and addressed by mass advertising campaigns. Marketing and advertising mass markets require mathematical statistical methods to discover regularities in large masses of data. The cyberworld provides a superabundance of data on consumers that can be mined to discover potentially profitable advertising strategies.

Today's capitalism is in large part the art of herding large masses of consumers, of manipulating them with clever advertising rhetoric whose sophistication reaches new heights with advanced tools of market research. The cyberworld provides a genial medium for fast consumer feedback that can be fed immediately into product strategies as a factor in a cybernetic feedback loop. The collection of personal data on consumers therefore becomes a political issue, for private persons are overwhelmed by the digitally enabled possibilities for revealing who someone is and what his or her life-movements are. Such data are interesting also to the state in its efforts to surveil the movements of its citizens in many areas including tax collection, crime, surveillance of citizens' political activity and political leanings, etc. The individual person is thus exposed to the danger of being stripped of the covering essential to freely leading a private life [18].

5. A Turing machine inside your head?

The previous section was dedicated to seeing more clearly how the artificial cyberworld is nested within the existential world of human beings. Under today's reign of subjectivist metaphysics, however, interest turns rather to how the idea of the Turing machine can be used to understand the cognition of the subject's mind, presumed to be located inside its head and more or less identified with the physical brain. Do neurons firing in your brain amount to bit-strings copulating computationally? By way of contrast, it will therefore be instructive to take a look at some thinking on so-called ‘computationalism’ as presented in a recent article surveying various positions represented in this ongoing debate. It goes almost without saying that the problem of time remains entirely foreign to this debate within analytic, subjectivist philosophy of mind.

“Computationalism is the view that intelligent behavior is causally explained by computations performed by the agent’s cognitive system (or brain).” [19] Although Piccinini nominally leaves open the question about whether the “agent’s cognitive system” can be identified with the brain, he still assumes that it is a *physical* system and obviously has the brain in mind as prime candidate for this physical system. In fact, he commits himself to connectionism: “In its most general form, contemporary connectionism simply says that behavior is explained (at some level) by neural network activity. But this is a truism – or at least it should be. The brain is the organ of cognition, the cells that perform cognitive functions are (mostly) the neurons, and neurons perform their cognitive labor by organizing themselves in networks. Modern connectionism is a platitude.” (p. 522) Connectionism does not amount to computationalism because neurons’ “cognitive labor” may not be solely computational, but connectionism is committed to the brain as physico-causal foundation. In turn, connectionism pairs with neuroscience which is making inroads everywhere today as the ultimate materialist ideology [20] [21] [22].

But let us go back to Piccinini’s starting-point. For him,

> Computationalism is usually introduced as an empirical hypothesis, open to disconfirmation. ... Computationalism becomes most interesting when it has explanatory power. The most relevant and explanatory notion of computation is that associated with digital computers. ... Perhaps cognitive systems work like computers. To a first approximation, this analogy between computers and cognitive systems is the original motivation behind computationalism. The resulting form of computationalism is a strong hypothesis, one that should be open to empirical testing. (pp. 516, 517)

This approach prejudices the question in multiple ways by proceeding from the unquestioned validity of empiricist scientific method, as if the ontological conception of mind, i.e. a question concerning the mind’s very being, could be decided along the path of scientific method. As has long been known, at the latest since Heidegger’s *Sein und Zeit* [6] and, later, Thomas Kuhn’s *The Structure of Scientific Revolutions* [23], any scientific hypothesis always already grasps the phenomena a priori in question in a certain way by virtue of its fundamental, crucial concepts. What is crucially in question is decided by this initial grasp (Vorgriff), the pre-conception. If it is hypothesized in some theoretical model that cognition could be “explained” by computation, and this hypothesis could be tested empirically for its “explanatory power” in terms of effective causality, this still begs the question concerning the mode of being of the mind, especially by taking for granted that explanations must be in terms of effective causality. It seems legitimate for scientific method to invent any theoretical model at all, so long as it delivers results in terms of empirically verifiable efficient causal connections.

All explanation is already problematic because an explanation explains a phenomenon in terms of something else that is supposedly already clear in itself. The scientist therefore looks *away* from the phenomenon itself in its simplicity, introducing something *else* (in this case: the model of a computing machine) that is supposed to explain its (in this case: the mind’s) movements. But it could well be that the phenomenon shows itself of itself quite differently and more subtly if one is patient enough to contemplate it simply and ‘tautologically’ in its self-presentation.

One issue within computationalism with its scientific methodology is how to explain *intentionality* in terms of computation, either partially or wholly. Here the question of the nature of time is implicit, but not explicitly raised. Intentions are said to have to do with “internal states – mental representations” (p. 523) postulated by scientists that motivate behaviour toward an end. Insofar this is new-speak for the traditional causa finalis, or teleological cause, that has come into disrepute since the rise of the modern physical sciences with their fixation on causa efficiens. Science does not want to accept that an end could cause behaviour in the sense of a motivation, but confronted with the phenomenon of an intention, it is hard-pressed to avoid it. “For example, Lori’s brain contains something that represents chocolate, which under the circumstances guides Lori’s behavior so that she seeks chocolate.”

(p. 523) It is, first of all, puzzling that the “brain” should contain “something that represents chocolate”.

Within the terms of neuroscience, this representation must be something like a wave pattern of neuronal activity locatable within the brain than, presumably, can be visualized on a monitor screen. This representation is then supposed to “guide” behaviour, in this example, toward a seeking. Guiding and seeking however, are oriented toward the future. Where is the future to be located in the brain? How could a neuronal wave pattern have the future in view? A pattern of brain activity that is supposed to be a representation is merely physical and blind toward the future. If this physical representation is to explain future behaviour, one must fall back onto *effective* cause which, of course, is blind. The temporal dimension of the future is thus eliminated. Or one dispenses with representations altogether for the explanation of behaviour (p. 525), which again does away with *insightful* behaviour. As we have seen above, computation is blind because a Turing machine has a blank ‘future’, so the intentionality of behaviour must be an add-on for any cogent computationalist account of the mind.

Strong forms of computationalism are generally rejected, either because they become too all-embracing, and thus vacuous, by conceiving of computation simply as a process where there is an input and an output (p. 517), or because certain essential aspects of cognition cannot be accounted for by computation; e.g. computation is said to be “insufficient for intentionality” (p. 525). But this still leaves computation as an important part of the explanation for which the Turing machine provides the model. Indeed, there is an argument in favour of computationalism that rests on the analogy between human minds as “cognitively flexible” (p. 529) and today’s all-purpose computers’ flexibility because they can be programmed to perform very many different tasks. It is therefore plausible for this suggestive way of thinking by analogy that computation in the sense of a Universal Turing Machine could be taken as an empirically testable hypothetical model for explaining cognition. Science then has something to work with in its quest for explanation, but its hypothetical model is nothing more than suggestive and, as we have seen, does violence to the phenomenon of time. Explanation and, even more so, *analogy* look *away* from the phenomena calling for elucidation. Arguing by analogy provides picturesque *metaphors*, another tried-and-true way of avoiding a thoughtful encounter with the phenomena themselves.

The orientation of the science of computational cognition remains to causally explain "intelligent behavior" (p. 515), either wholly or partially, in terms of "computations performed by the agent's cognitive system (or brain)" (p. 515). Computational explanations are out to get a pre-calculative grip on human behaviour. As such, computationalism aims unquestioningly at control over human behaviour, like all the other modern human and social sciences. Such control may take the mild form of predictive explanation in contrast to a productive technique, but the explanation remains committed to *efficient* cause nonetheless. The Turing machine is amenable as a model for cognition, because it, too, computes solely through efficient causation, namely, a stepwise, logically efficient causation that determines the output computed. That the human mind is capable of following such logical consequences is uncontroversial. After all, it is human beings who design Turing machines to compute algorithmically the way they do in line with logical causation; and it was one singular human being, Alan Turing, who first had the ingenious idea of a universal computing machine. He had in mind problems he intended to solve, e.g. What does mechanical computation mean? Can the Entscheidungsproblem be solved? Insofar he cast his mind toward the future, imagining the unsolved problem, and his endeavours were oriented toward a goal, an end, a τέλος.

Similarly, when computer programmers approach a problem, they have in mind a problem wanting solution and so must first gain an understanding of the problem situation and all the boundary conditions in play. Only within the restricted environment of a relatively limited problem situation can the problem be attacked, e.g. writing a program to flexibly generate an airline's timetable among a finite number of destinations. Today there are standard procedures for tackling such a task that can be employed. The main task, however, is to *translate* an understanding of the problem and its boundary conditions into an algorithm that can compute a solution for varying input. Such translation is not a computational problem, just as little as a mathematician's proof of a theorem. The finished proof itself must be logical, obeying the laws of inference within mathematics and building up on a previously body of mathematical proofs, but how the idea for the proof first occurred to the mathematician remains a matter of previous experience in problem-solving and sheer flashes of insight.

Another word for insight is intuition, whose German translation, 'Anschauung', is telling because 'anschauen' means simply 'to look at'. You just look at the problem and maybe something will occur to you when you're under the shower. Yet another term for insight is power of imagination, which is the power to envisage in the present something absent, wanting, which may or may not eventually come to presence from the future. Modern thinking, however, including a variant called computationalism, begs the question of the temporal dimension of the future. It is taken unquestioningly for granted. If you think it is plausible that you have a Turing machine inside your head, you need to rethink.

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