Labor, Machines and Energy in Capital's Ecology: The Case of Artificial Intelligence

Introduction: living and dead labor

Capital is famously resilient in the face of crisis. When profits fall, it excels at finding new ways of cutting labor costs, securing subsidies and bailouts from the state, threatening workers, dreaming up new financial instruments, assimilating fresh frontiers where cheap resources can be extracted, managing the resulting resistance, and creating new commodities whose sale promises to mitigate problems the old ones caused. But capital's crises are resilient too. They come back again and again because they are built into the process of capital accumulation itself. The machinery of profit is always undermining its own foundations. That necessitates recurring scrambles to find new ones – which it likewise progressively degrades (Moore 2022).

This contradiction goes by many names. Karl Marx (1990 [1867]) referred to a running opposition between "living" and "dead" labor – between the activities of live humans and the routines of nonliving machines in which past labor was "congealed." Marx saw the two as yoked together in industrial capital yet irredeemably at odds (Antunes 2018). Machines controlled, reorganized, recruited, regimented, degraded, dominated and partially usurped workers' actions, as well as speeding up the production and circulation of the commodities that they were made to need for survival. Yet profits couldn't be made without finding more and more living human laborers and making their survival dependent on working the new machines and correcting their inbuilt inadequacies. Far from machines decreasing human toil and drudgery, they expanded its range, helping spread slavery and the wage labor relation around the world (Huber 2009). This chapter argues that a new version of this dynamic has emerged with artificial intelligence (AI).

The particular amalgam of industrial machines and human labor represented by AI is unstable partly because the particular machines involved, like their ancestors, have an inherent tendency to interfere with the "life of labor-power, in the same way as a greedy farmer snatches more produce from the soil by robbing it of its fertility" (Marx 1990 [1867]: 376). Just as they always have, humans return the favour by wrecking machines or messing with their operations in less dramatic ways (Merchant 2024; McKittrick 2016). Hence when capital tries to recover from crisis by combining new machines with new initiatives to plunder and degrade the nature that is required to run them (including human nature), the solution is always temporary (Mitchell 2000). Fizzy, vulnerable new frontiers of life constantly have to be sought out as old ones go flat (Colatrella 2002; Malm 2012; Perelman 2000). Capital's machinery is like a vampire in that it "lives only by sucking living labor, and lives the more, the more labor it sucks" (Marx 1990 [1867]).

This is no kind of recipe for sustainability. Where do vampires go once they have bitten everybody on the planet? Profit is always on the point of falling as the number of unbitten blood donors dwindles. Eras of high productivity regularly slump into periods of what Moore (2015) calls "falling ecological surplus." There can be no such thing as a globally "circular", "steady-state", "no-growth" or "green" capitalist economy (Polimeni, Mayumi, Giampetro et al. 2008). Billionaires like Jeff Bezos and Elon Musk admit as much when they tell us that the earth itself must ultimately be abandoned as a matrix for accumulation (Asher Hamilton 2019, Tangermann 2025).

This chapter puts some theory around these ideas by updating Marx's notions of living and dead labor to illuminate the triple theme of capitalism, nature and sustainability. It takes advantage of the

timely example of AI to help explicate the enduring contradictions between the two at the same time it uses them to help explain the contradictions of AI.

The argument runs as follows. The next section unpacks three key features that set living labor apart from dead (animate movements, rhythms and rules), using materials from contemporary research in biology, physics, archaeology, robotics, music, philosophy, history, anthropology, computer science, psychology, linguistics and other disciplines. Throughout, a contrast is drawn between the thermodynamics of life and the thermodynamics of AI. The next section mobilizes these points to demonstrate why the example of AI illuminates central questions about capitalism, nature and sustainability, and how capital's history in turn illuminates the nature of AI. The chapter concludes that a liberatory approach to labor and environmental crisis needs a closer look at the nature of life itself.

What Sets Living Labor apart from Dead Labor?

Animate movements

What does the living labor of humans give to capital that AI and other forms of dead labor don't? Marx was partial to phrases like "vital force," "will" and "form-giving fire." Today there are less vitalistic ways of speaking. Some of the most fundamental come out of the energetics of life, a field pioneered by figures such as Erwin Schroedinger (1944) and Ilya Prigogine (1997).

One lesson of this growing body of theory is that workers can live to work another day for capital only if their bodies remain well out of what is called *thermodynamic equilibrium* with their surroundings. Living bodies need to maintain at every moment a thermodynamic boundary between an "inside" of low entropy and an "outside" of higher entropy which are nevertheless in constant interaction. That involves staggeringly complicated respiratory chains featuring protons flowing back and forth across strange membranes, electrons hopping from one redox centre to another using quantum means, and all sorts of other exotic structures (Lane 2015). Fundamental to it all are movements that help bring food across the boundary of the worker's organism and expel high entropy to the outside.

What is the nature of these movements? To find food and warmth and get away from waste and toxins, animals like vertebrates, arthropods and even single-celled motile organisms need what is called *proprioception* – a sense of their own bodies as distinct from their surroundings (Gibson 1979). As Maxine Sheets-Johnstone (2005, 2008) has argued at length, the capacity for this animate form of movement is a necessary condition for the subsequent evolution of hominin toolmaking, dance, music, cooperation, language and the propositional knowledge that comes with it – that is, everything that we usually call cognition, mind and value. Living labor is all about animate movement – and, behind that, proprioception and the thermodynamic predicament specific to life. Examine any work skill like tilling fields, driving cars, changing diapers, wielding hammers, executing keystrokes or folding sheets and this biophysical sophistication and complexity quickly reveal themselves.

This does not imply that the electromechanical movements of AI machine networks – which are not animate in this sense – could never emulate or imitate cognition in ways that would allow them to take on the role of living labor in capitalism. But it does indicate challenges seldom acknowledged by those claim that they could, such as Elon Musk, Sam Altman, Jensen Huang, Mark Zuckerberg, Dario Amodei, Geoffrey Hinton and countless others.

The first of these challenges is thermodynamic. While they are operating, industrial machines such as Nvidia H100 GPUs are just like living beings in that they are located on boundaries between low and high entropy. They have to take on low-entropy electricity while expelling high-entropy heat. But there the similarity ends. Unlike workers, industrial machines can be "on" only when they are deliberately placed on those boundaries or have new boundaries constructed for them. They can't sustain the boundaries by themselves. A machine left to itself eventually runs out of fuel while clogging its environs (and itself) with waste, attaining relative thermodynamic equilibrium. To keep performing for capital, the machine needs humans to transport it to new fuel sources or transport new fuel to it and to clean up after it. That entails an ever-changing *global* landscape of extractive sites, bulk transports and pollution sinks – each with its own additional machines with their own fast-eroding entropy borders. Today there is a world-spanning landscape of rapidly-disappearing and purpose-built new entropy slopes that is entirely different from and in many ways antithetical to the entropy landscapes to which humans owe their evolved capacity for the animate movement that underpins capitalist labor. Like other industrial machine networks, AI can only function by devaluing these landscapes and transforming them into moving entropic frontiers organized instead around the commensuration of the energies of the commons into the omnibus imperial energy developed during the 19th century (Lohmann 2025). The more that AI is made to appear as if it were approaching the status of living labor, the more committed its proponents must become to the construction of thousands or millions of energy-ravenous data centers on earth and in space. Popular resistance is inevitable and growing fast. It is fatuous to bloviate about which particular human skills AI might be able to simulate next year or the year after that without addressing the differences between the ecology of computation and the ecology of cognition.

Rhythms

One subset of animate movements is rhythms, which are also central to living labor. Any machine network aspiring to the ability to perform all human tasks will have to replicate their function.

Again, however, the challenges have been underappreciated. This neglect has historical roots. Even Marx, although he is constantly analyzing transformations of nature "through labor and consciousness," never "discovers rhythms" (Lefebvre (2013 [1992]). And Marx has plenty of company. For hundreds of years, rhythms have been so often simply equated with machine repetitions that today few people bother asking how AI machines could imitate them. For example, many beginning music students assume that defining a regular beat must be the prerogative of the metronome – an invention of the early industrial era – rather than of the skilled, biological body in self-movement among others. Contemporary AI hype, meanwhile, rests on the assumption that merely by "scaling up" (Hao 2025) the number of repetitive electromechanical motions that computer processors make using increased inputs of abstract energy, those motions will one day yield the rhythms characteristic of a living being striving to "preserve the integrity of its [entropy] boundaries while having constant interchange with the environment" (Rosch 2017 [1991]).

Hence it's crucial to restate the ways in which rhythms are different from – and evolutionarily prior to – the much narrower class of machine repetitions. One difference is that rhythms are *in time*, whereas repeated machine motions are *over time* (Smithers 1998). With living things, the time taken for a process matters to its structure and outcome. Humans can't walk, speak, sing, weave, calculate, translate (Liu 2019), diagnose or work a thousand times faster or slower than they do, any more than the soil that Marx referred to in *Capital* can accelerate a thousand times the repetition-filled biochemical and ecological interactions that make it fertile enough to sustain human life. Machine repetitions, on the other hand, can in theory be speeded up or slowed down indefinitely while remaining the same movements and issuing in the same commodities. The "temporality of a

computational process," in particular, is "theoretically immaterial" to the result of that process (Iyer 2004: 161). It's irrelevant to an algorithm how quickly an assembly of computer chips can run through its steps. In a machine, time is encoded as a "chase through a diagram" (Rosen 2005 [1991]: 223) – a chase unconstrained by the multiple, interlocking rhythms of life.

To take another example, the regularity of the motions of a carpenter wielding a hand saw differ in kind from the regularity of the motions of a mechanical rotary saw (Ingold 2006). While each of the virtuoso carpenter's strokes can be said to be the same as the one preceding it, it is also *not* the same (Bernstein 1967). It involves "repetition without repetition" (Ito 2015). To make sure of doing the "same" thing with every stroke, the carpenter will have to do something different – for instance, to vary the point she starts her upstroke from depending on workshop circumstances, to adjust her balance in accord with her body's physiological endurances, to correct for any chance inaccuracy in her last stroke, even to perceive the board that she is sawing differently (Gibson 1979). Force, amplitude, speed and torque vary from stroke to stroke, as does the carpenter's posture, all dependent on uninterrupted proprioception. Living labor, unlike the dead labor of machines, is full of "differences induced or produced by repetition" (Lefebvre 2013 [1992]).

By the same token, children learn to walk like machines only *after* they learn to walk like humans. Robot impersonation is of little interest to capital other than as entertainment. It is useful neither for life nor assembly lines nor capital accumulation. Similarly, metronomes or click tracks become useful devices for music students only long *after* they have first displayed, as prelinguistic babies, the foundational ability to keep the social beat with their little feet, legs and arms. In short, the regularity of the movements peculiar to living labor cannot evolve within the isolation of machine environments but only in an unpredictable wider socionatural world and its multidimensional, long-evolved "taskscapes" (Ingold 2000), within which alone pre- and post-linguistic "rehearsal loops" become active (Tomlinson 2015).

Lefebvre (2013 [1992]) and Ingold (2006) encapsulate the point of this section by noting that while machines move repetitively, only living beings have *rhythm*. One corollary of this view is that only living entities have skills. It is only because the differences between animate and machine repeated movements have become so obscured in modern European culture (Daston 2022) that it has become so difficult to articulate the core of truth in seeming paradoxes such as that power looms cannot weave, metronomes cannot keep a beat, and, as Wittgenstein once remarked, computers cannot calculate (Shanker 1998).

Rules

Rhythms offer stepping stones toward *rules*, another concept central to understanding living labor and its contradictory relations with dead labor.

How are rhythms and rules connected? Archaeologists have described sequences of practices that hominins would have used to make highly symmetrical Acheulean stone bifaces between 1.75 million and 150,000 years ago (Tomlinson 2015). Such sequences would have included the kind of rhythmic, situated "same-but-not-the-same" strokes described in the previous section – the kind of strokes needed to chip flake after flake off some likely lump of stone to yield a useful tool. The relevant skills, embedded in a heterogeneous ensemble of other practices and opportunities specific to particular times and places, would have been passed on from generation to generation without either having been completely "pre-programmed" genetically or requiring language or music as we know them today. Indeed, far from presupposing language, such skills might be better regarded as underpinning it.

Retrospectively, such rhythms can be described using English phrases like "repeated performances of the same movement." But concepts like *repeated* and *same* wouldn't have been present at the time. Our contemporary ability to map rules onto such such rhythms does not imply that the Acheulean toolmakers themselves were following such rules. Rule-following would have unambiguously emerged only when compositional, combinatorial linguistic structures developed on top of earlier, more intrinsically-contextual gesture-vocalizations (Tomlinson 2015). That's when it would have become possible for one hominin to ask another something like "Are these motions the *same* as what you're doing?" – and, eventually, "Are these movements *correct*?" and "Am I following the *rule*?" To put it another way, the tightly-knit cluster of concepts that encompasses *same/different*, *correct/mistaken* and *obeying/disobeying* came after, and is in some ways derivative of, rhythms that were already present. The same goes for other members of this conceptual cluster including *repetition*, *regularity*, *replication* and *duplication,* as well as later additions including linguistic *rules*, legal *contracts* and scientific *laws*, mathematical *recursion*, culinary *recipes,* computer *algorithms*, and so forth. To switch the focus from archaeology to child development, a baby can teach herself and be taught to sharpen her entrainment to regular beats long before she learns language. Her subsequent acquisition of the additional ability to handle concepts centering on the notion of "the same beat" is a matter of progressive "triangulation" (Davidson 2001) among the antics of an active external nonlinguistic world that includes all sorts of such rhythms, the performances of her own organism in animate motion, and the actions of her language-proficient elders.

One constant between rhythms and rules is that both revolve around "sameness-that-is-not-sameness." Rules, like rhythms, represent unfolding variation inside constancy. No one can predict all the ways in which rules will need to be reinterpreted and reapplied in future socionatural circumstances (Wittgenstein 1953, Collins 1985), any more than they can predict the exact trajectory of each of the next of a series of repeated strokes that a skilled carpenter will need to make with a saw (Ingold 2006, Iyer 2004). No sooner had the early Soviet psychologist Nikolai Bernstein (1967) pointed out that exercises of the ability to repeat the same motions that athletes or workers are trained to acquire can never be exactly the same even in their physical measurements than Ludwig Wittgenstein (1953) added that something similar applied to interpretations of the "same" rules. A parallel example involves the "sameness" of meaning between a chunk of linguistic behavior and its "equivalents" in another (or the same) language. For chunks that are the length of a single word, the equivalences (or "samenesses") that a living translator might produce in any given circumstance are predicted well enough – at a relatively low energy cost – by the "conversion rules" listed in dictionaries. For longer passages, at energy costs that skyrocket in proportion to their length, predictions of comparable utility require blindingly complex conversion rules mediated by phenomenally energy-greedy neural networks and continuous "deep learning." The point is that any such rules, regardless of their complexity, will reflect the requisite "sameness that is not sameness" only to the degree that they are parasitic on energy-frugal living interpretive or translation labor. The meaning of any word or passage is derivative of the labor of interpretation or translation rather than the other way around (Quine 1960). Because that labor consists of historical, political acts that are "in time" (Smithers 1998) rather than being indefinitely accelerable (Liu 2019, Sakai 2009), mechanical or electromechanical repetition would need to strain the energy resources of the entire universe to try to catch up with the "sameness-that-is-not-sameness" that is a part of the ongoing processes by which workers understand one another and the world.

To be sure, most educated people today have the feeling that a rule (or, alternatively, the meaning of a word or passage) must be something at once firmer, more autonomous, and more private than that. For example, they feel that the rule "add 2 to the previous number" compels them from within to produce the single determinate sequence "2, 4, 6, 8, 10, 12, …" rather than, say, "2, 4, 6, 8, 10, 10,

10, …" (Kripke 1985: 21-22). They resist out of hand alternative interpretations of the rule – such as, for example, "add 2 to the previous number (until you get to 10, obviously, then add nothing)". But in fact it is only over the last few hundred years – amid the fitful development of what the historian of science Lorraine Daston (2022: 273) calls "islands of uniformity, stability, and predictability" (in part to make machines and divisions of labor work for the benefit of elites) – that it has become possible for people to believe that there are such things as "rules that follow themselves, everywhere, always." And to imagine that such rules – carrying their own inner power, authority and autonomy – can be encased inside brains or machines, along with fixed "meanings" independent of the living labor of interpretation.

Such dubious intuitions pave the way for the theory that cognition must be a sort of "digestion" (Shanker 1998) or computation carried out by a "language module" or even "master algorithm" (Domingos 2015) built into individual brains (Ibbotson and Tomasello 2016) and transposable to machines. The influence of this machine fetishism (Hornborg 2023) in contemporary society cannot be underestimated. It pervades mainstream physics and biology (Rosen 2005 [1991]), linguistics, policymaking, popular culture and science fiction alike – not to mention the doctrines of "scalability" and "singularity" subscribed to by many mega-investors in AI. Only when confronted with the infinity of possible ways of obeying any rule or "going on in the 'same' way" (Wittgenstein 1953) does this pseudo-science collapse (together with much propaganda disseminated by firms like Meta, Nvidia, OpenAI, Google, Microsoft and Apple).

One upshot is that there exist forms of compulsion indispensible for capital accumulation that inhere in living but not dead labor. Naturally, living and dead labor are equally subject to the type of energetic compulsion that drives a billiard ball away from a collision with another or closes an electronic gate. But other forms of compulsion are found only in living labor. These include the compulsions connected with inherited animate movement capacities that first came into being hundreds of millions of years ago. Much later came entrainments into rhythms that have components that can be improved through practice in a group. Those date to perhaps hundreds of thousands of years ago. Then there are the kinds of compulsion that derive from social apprenticeship in linguistically-enhanced contexts in which rules have become active in governing hands, legs and tongues. These can be traced back perhaps tens of thousands of years. All three forms of compulsion – and others – must be included in the immense ecological heritage that capital seeks to tap for free in both its exploitation of workers and its appropriation of nature. All three, and more (Mau 2023), need to be grasped in detail to understand just how fundamental the contradiction is between living and dead labor.

An up-to-date understanding of the distinctive type of compulsion inherent in rules, for example, is essential to understanding the reasons why capital accumulation paradoxically depends on resistance to itself (Caffentzis 2013, Johnson 2017). Business management is about getting others to do things. But obedience always implies the possibility of disobedience. Lay down any rule for the worker and the worker can find a way to subvert it by reinterpreting it. One example is the protest tactic of "working to rule" – irritating bosses by following their rules "too mechanically." Fitfully, capital strives to halt the never-ending dance of interpretation, reinterpretation and re-reinterpretation by using energy-intensive mechanization. The hidden fantasy is to make its rules unreinterpretable – to eliminate once and for all the worker's living interpretive labor. Imagine how streamlined and efficient rule-following would be if it didn't require interpretation at all! If the metronome can be recruited as the basis for correct rhythm, the fantasy goes, the industrial or digital machine can be recruited as the model for rule-governed behavior. But this tactic brings new problems. Since machines can't do their jobs the "wrong way," they also can't do them the "right way." They need humans full of historic and prehistoric experience of the flexibilities of rule-following and rule-flouting to fix them, clean up after them or find new ways of feeding or

adjusting them to surrounding socionatures to deal with unanticipated circumstances. They need living laborers who – unlike the "bullshitters" that AI mechanisms are designed as (Hicks, Humphries and Slater 2024) – can distinguish between real and unreal due to their histories of biophysical interactions with objects within a community of other human individuals observably reacting to the same objects (Davidson 2001, Rosen 2005 [1991]). No capitalist who actually succeeded, *per impossibile*, in mechanizing away the interpretive labor of ordinary workers would ever be able to accumulate anything. Nor, conversely, could any anti-capitalist attain a world of "luxury automated communism" (Bastani 2021) by offloading subsistence-oriented animate activity onto machines. Far from replacing living labor, machines only increase capital's desperate need for it – and, ironically, for the ever-shifting wellsprings of defiance that come with it. What is popularly called automation is always, in fact, the highly-unstable hybrid of living and dead labor that Hamid Ekbia and Bonnie Nardi (2017) term *heteromation.* Despite incessant propaganda from regulators, policy elites, AI companies and university think tanks (OpenAI 2026; Ji, Qiu, Chen et al. 2025; Politics UK 2026), AI machines are not going to "align" themselves with social goals or human values; they can only *be* aligned by continuous infusions of living labor (Arvan 2025: 3769).

From Marx to AI and back again

This chapter's update of Marx's old contradiction between living and dead labor does two useful things. First, it recruits the longer history of industrial capital to identify what the central political-ecological issues surrounding AI are, cutting through the nonsense that dominates most critical commentary on the subject. Second, it provides fresh grounds for arguing why Marx was not wrong in sensing that the living/dead labor contradiction lies at the heart of capital's unsustainability. Putting past and present in conversation with each other in this way helps reinforce the point that the most effective popular resistance strategies around AI, in bringing together labor, ecological, feminist, anti-racist and anti-imperialist movements, will be those that challenge capital itself.

Capital's 21st-century fantasies of artificial general intelligence are a sequel to its unrealized 19th-century dreams of defeating the stubborn resistance of laborers and other living things through earlier forms of industrial mechanization. This should be no surprise. Today's AI is ultimately rooted in Joseph-Marie Jacquard's programmable looms (Essinger 2004), Charles Babbage's computing engines (Schaffer 1994), and other 19th-century innovations that were deliberately designed as weapons in capital's war against labor. Artificial intelligence, like earlier heteromation ventures (Gray and Suri 2019), originates in the strife-laden efforts of the rich to use machines to get richer at the expense of the poor. The imaginations of 19th-century industrial barons like Cornelius Vanderbilt, Andrew Carnegie and Leland Stanford differ little from those of 21st-century AI proprietors such as Elon Musk, Mark Zuckerberg and Sam Altman. The bumpy history of industrial robotics (Brooks 1999), automated image recognition (Jia, Wei, Socher et al. 2009), generative algorithms, and even the remote exploration of Mars (Clancey 2001) continues to illuminate venerable dilemmas afflicting industrial capital going back more than two centuries.

The thermodynamic continuity between early industrial capitalism and AI capitalism is especially marked. In both eras, the contradiction between living and dead labor permeates deep into the landscape itself, as the spaces and times of rural commons are subordinated to the abstract energy on which industrial machines, including those housed in data centers, depend for their capacity to produce super-fast, indefinitely-accelerable repeated motions. In the case of AI, the dominance of 19th-century abstract energy (Daggett 2019, Lohmann 2025) integrates *forward* into a social regime characterized by increasing reliance on mass production of statistical predictions and the belief that, if their numbers can be "scaled up" enough, such predictions can defeat the power of living labor. At the same time, it integrates *backward* into catastrophic processes of degradation (likewise

familiar from the 19th century) of soil fertility, biodiversity, climate stability and human resilience by plantation and other extractive, polluting economies (HM Government 2025).

As in the past, both aspects of this deterioration tend to provoke Sisyphean struggles on the part of capital to locate more and more cheap living labor to clean up the endlessly-accumulating mess. On the one hand, billions of humans must be recruited to absorb AI wastes and environmental stresses that they are evolutionarily unequipped to deal with, as well as to "offset" or delay the effects of AI's accelerating ecological disruptions (Beuret, Fitzmaurice and Harvie 2025; Kratli 2026). On the other hand, billions of low-paid or unpaid humans must be found who can take on the rhythmic, rule-governed, fatiguing machine-care labor that encompasses what sociologist of science Harry Collins (Collins and Kusch 1998: 123-125) calls "RAT-work" ("repair and attribution and all that"). RAT-work includes fixing and preparing data for AI models (Mejias and Couldry 2024); interpreting, anthropomorphizing or censoring computer outputs (Collins 1990); clearing away "AI slop" (Niderhoffer, Kellerman, Lee et al 2025); and otherwise adapting AI machine repetitions to human society and vice versa. One of the most important functions of RAT-work is to hide, in classic 19th-century Industrial Revolution fashion, how much living labor is going into machine-human interactions, making it possible to ignore the magnitude of the conflict between the long-evolved biosocial "same-but-not-the-same" and the mechanical "same" that has been one focus of this chapter. That makes it easier to hype AI as having the potential to "do it all by itself," thus reinforcing capital's triple propaganda strategy of threatening workers with redundancy, simultaneously promising them a new leisure age of "full automation" (Bastani 2021), and attracting massive AI investment. It also conceals how little AI machines are actually contributing to productivity (Mazeika, Gatti, Menghini et al. 2025), encouraging the wild speculation that is the mark of AI investment in an era of wholesale financialization and hastening the rush toward an AI-driven global economic crash. Finally, millions of members of the living public are given the onerous job of adjusting themselves to the increased volumes of "waste" in the form of murdered civilians that are inevitable when AI accelerates the heteromation of "kill chains" in wars and genocides in Gaza and elsewhere (Baker 2026).

To overlook these continuities in the story of living and dead labor would be to handicap liberation struggles. For example, to insist that policymakers allow large AI corporations to continue on their current trajectory, merely "regulating" them after the fact for the public good – "mitigating" AI "side effects," making AI more "accessible," "reconciling" it with "human values" – would be to betray popular movements already poised to to take advantage of the deeper, inherent energy and labor contradictions of the technology. To advocate responding to AI by merely "seizing the means of computation" while assuming that AI's larger ecological structure can somehow be contained within expert-delineated "social and planetary boundaries" (Kwet 2024: 200, 212) would be to fall victim to the same machine fetishism (Hornborg 2023) that has often stood in the way of popular struggles in the 19th and 20th centuries. To endorse industry or academic claims that AI is advancing a brand-new "knowledge capitalism" risks reproducing the classism and racism inherent in the obsolete idea that old-fashioned manual labor is somehow *not* cognitive or intellectual in its constant reliance on the interpretation of rules. That too would be to hamper possibilities for movement alliances. Similarly, to allow oneself to be surprised that AI is having difficulties finding enough cheap living labor to produce data "big" enough for its mechanized algorithms (Shumailov, Shumaylov, Zhao et al. 2024) would be to forget that a similar thing happened in the 19th century when Eli Whitney's cotton gin necessitated expanding the number of slaves many-fold – and indeed whenever capital has had to scramble to locate enough living labor to nurture its expanding technomass (Hornborg 2001) and thereby try to avoid the tendency of the rate of profit to fall (Marx 1981). To hype the prospective predictive abilities of AI without mentioning animate movement and the thermodynamics of life would be like talking about the political achievements of the US's Founding Fathers without mentioning slavery, patriarchy or settler colonialism. By the same token,

to empower AI tycoons by giving credence to their perennial claims that self-contained "green" machines are well on the way to diagnosing all illnesses, solving climate change, or driving cars all by themselves would be to fail to grasp the political realities of energetics, rhythms and rules that this chapter has taken pains to spell out. In short, for social movements to treat AI as if it could be a neutral tool for improving human lives – as if it were an object that could float free of its origins in crises of capital going back to the 19th century and before – is likely to result in tactics that undermine the causes of sustainability and the defense of nature.

Conclusion: taking life seriously

Exploring and developing Marx's contradiction between living and dead labor through the analysis of artificial intelligence opens new possibilities for setting aside a whole cluster of reactionary standard modern dualisms – often labeled, although a bit simplistically, "Cartesian" (Riskin 2016). These dualisms, unfortunately, continue to be routinely invoked not only by capitalists but also by the great majority of their educated would-be adversaries. They include, among others, dichotomies like discursive/material, intellectual/manual, mental/physical, design/execution, information/matter, society/nature, head/hand, human/territory, society/resource, culture/nature, plan/implementation, mind/body, strategy/process, subject/object, meaning/substance, in-here/out-there, and word/world. All these dualisms tend to be toxic to popular movement-building insofar as they attribute race, class and gender domination to the eternal structure of the universe. For example, to say that bodies need to be animated by minds or nature by society is to imply that bodies and nature lack animation in themselves. That is a racist doctrine insofar as it dismisses entire ways of living followed by many Indigenous and other (usually darker-skinned) peoples. Similarly, to say that intelligent action requires prior symbolic processing is a telltale justification for the hegemony of a self-styled "educated" or bourgeois class (Federici 2004, Moore 2022). And so on.

Such dichotomies reflect a politics that has been especially pernicious in the age of industrial capital, and never more so than in the current age of AI. Dangerously, they assimilate the body and the rest of nature to the kind of machines that started arriving *en masse* around 1800, while etherealizing the equally earthly categories of ancient animate movement (Sheets-Johnstone 2005, 2009) and rhythm (Tomlinson 2015, Iyer 2004) as well as the more recent phenomenon of rule-following (Wittgenstein 1953, Daston 2022). This is one factor that has kept popular debate about AI since around 2010 largely corralled inside a fixed set of nonsensical questions. Are machines going to take all our jobs? Will they murder us or instead provide us with lives of leisure that allow us to maximize our creativity? Does AI pose an existential threat to humanity, or will it, on the contrary, save us from ecological catastrophe? Is a singularity coming soon in which mind will suddenly emerge from machine matter? Will we be able someday to transplant our human essence into machines? Other, more coherent and interesting questions too often get left on the sidelines. These are the questions that this chapter has emphasized concerning labor, ecology and energy.

Popular movements, including movements opposing AI development, may therefore find it empowering to sidestep such abstract yet temptingly simple dichotomies in favor of the less fossilized divide proposed in this chapter. This is the distinction between the machine/entropy networks of the last few centuries of industrial capitalism and the organism/entropy networks that have evolved over the last 4,000,000,000 years. On one side lie a special, very recently-developed class of potentialities for accelerable repetition associated with steam engines, wind turbines, dynamos, SUVs, solar panels, automobiles and data centers, together with the speeding up of production and circulation of commodities and the development of a corresponding kind of entropy landscape process. On the other lie abilities to perform a different type of repeated action that belongs to manual laborers, musicians, computer scientists, horses, mangroves and agricultural soils, all integrated into quite different, overlapping patterns of landscape evolution. These two

types of repetition conflict with each other at numerous points. For example, the geography associated with the sustenance of forests, watersheds or human labor skills is often at odds with the geography of AI capital.

One virtue of this proposed substitute division is that it avoids foreshortening the prehistory of life that connects the two kinds of motion that this chapter has distinguished. It reveals its historicity in the very way it is stated. In refusing to sublimate the story of life out of the body (Rosen 2005 [1991]), moreover, it avoids the trap of sublimating agency out of plants, animals, microorganisms and the land itself. Along the way, it suggests reasons for avoiding the unconstructive temptation – to which even leftist thinkers like Malm (2019) are not immune – to retroject historically-embedded dichotomies like society/nature or mind/body into an undefined *illo tempore*.

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