

## Vectors for Workers: Models of Automation and Autonomy in the Long AI Century

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*In memoriam Paolo Virno (27 June 1952 - 7 November 2025)*

The division of labour under the system of manufacture not only simplifies and multiplies the qualitatively different parts of society's collective worker, but also creates a fixed mathematical relation or ratio which regulates the quantitative extent of those parts—i.e. the relative number of workers, or the relative size of the group of workers, for each special function. Thus alongside the qualitative articulation, the division of labour develops a quantitative rule and a proportionality for the social labour process. (Marx 1867/1981: 465)

Information, like land or capital, becomes a form of property monopolized by a class, a class of vectoralists, so named because they control the vectors along which information is abstracted, just as capitalists control the material means with which goods are produced, and pastoralists the land with which food is produced. This information, once the collective property of the productive classes—the working and farming classes considered together—becomes the property of yet another appropriating class. (Wark 2004: 29)

**Abstract.** The rise of AI should be read not as a neutral technological advance but as the latest stage in the long struggle between capital's drive towards automation, labor's resistance to exploitation, and society's quest of autonomy. To situate AI within this history, existing theories of automation must be revisited and expanded. A theory of automation is not a study of technology's 'impact' on society, but rather a causal model explaining how automation develops and why it takes one form rather than another. Theories of automation can be divided into four categories: value theories, labor theories, metric theories, and standpoint theories. Despite extensive literature, an organic theory capable of addressing AI as part of long economy cycles, seeing together its microeconomic and macroeconomic dynamics, is still lacking.

## Enters abstract labour

The rise of AI should be read not as a neutral technological advance but as the latest stage in the long struggle between capital's drive towards automation, labor's resistance to exploitation, and society's quest of autonomy. To situate AI within this history, existing theories of automation must be revisited and expanded. A theory of automation is not a study of technology's 'impact' on society, but rather a causal model explaining how automation develops and why it takes one form rather than another. Theories of automation can be divided into four categories: value theories, labor theories, metric theories, and standpoint theories. Despite extensive literature, an organic theory capable of addressing AI as part of long economy cycles, seeing together its microeconomic and macroeconomic dynamics, is still lacking.

Certainly, the question concerning technology inherits past unresolved controversies.<sup>1</sup> In the 19<sup>th</sup> century, philosophers debated automation through Hegel's notion of abstract labour, which Marx deeply criticised. Hegel saw the machine as a materialisation of workers' abstract labour, that is the abstraction of the division of labour, while Marx saw the machine as a materialisation of capital's abstract labour, that is the abstraction of value. Adam Smith's analysis of the division of labour influenced Hegel's idea, while it has been forgotten that Marx engaged with Charles Babbage's principles of labour calculation and automation. All these references remain useful to illuminate the role of technology in the capital-labour nexus, but a schism took place: at least in Western critical theory, theories of automation based on the labour form are opposed to those based on the value form. How to recompose such a schism?

Concerning the predicament of Western capitalism, a consensus can be found around the following theory of automation: technological development is simultaneously driven by an economy of profit (*selling*

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<sup>1</sup> This essay considers the terms mechanization, automation, automatic control and automatization as conceptually homologous by stressing the common social abstraction that shapes all of them. Automation was introduced by Delmar S. Harder, vice president of Ford, in 1948. Friedrich Pollock (1956) distinguished automation from mechanisation according to the increasing role of information in the control process.

more or more expensive commodities), time (*making things faster*), space (*organizing things in less space*), energy and resources (*making things cheaper*), and particularly labour (*paying workers less*). The labour component, that is part of a broader social antagonism, is key. The way in which workers are measured and remunerated, and whether or not they resist measure and remuneration, crucially affects technological innovation. History teaches that automation is introduced where labour resistance is stronger and labour cost high, yet other factors play a role. In other historical and political contexts, indeed, the theory of automation can take other forms and be investigated according to other value systems, worldviews, and even cosmologies. In a non-capitalist mode of production, for instance, automation could be driven by an economy of equity (*paying workers fairly*), prosperity (*producing necessary and useful goods*), and sustainability (*minimising the consumption of space, time and resources*). One must consider that any automation theory is a space of political intervention: theory is not only descriptive but also prescriptive and it can be employed to shape the design of technology itself. This initial caveat is necessary to acknowledge that any history and philosophy of technology, like the one following, is always an exercise of political synthesis.

For reasons of presentation, this paper divides automation theories in four groups: **standpoint, labour, metric, and value theories**. In short: standpoint theories stress the role of social antagonism in the making of automation; labour theories highlight the role of the division of labour in the design of automation; metric theories see automation as a form of measure and calculation; value theories explain automation within an economic process and usually remain agnostic to its design. All these positions are entangled and dialectical. In the book *The Eye of the Master: A Social History of Artificial Intelligence* (Pasquinelli 2023) I focused mostly on the labour theory of automation as a lens to read AI: in this text I try to integrate other theories with the commitment to sketch an *organic theory of automation* in the long century of AI, that is an epoch of knowledge automation that started at least with the industrial revolution.<sup>2</sup>

This presentation of the problem of automation in this way and the project of an organic theory takes inspiration from Part IV of *Capital*, where Marx frames machinery as a means for the production of **relative surplus-value**. Marx's argument is systematic. He descends from capital into the ramifications of the cooperation of labour and, then, into the organisation of industrial machines and large factories, ending with the recognition of working class's resistance against capitalist machines. Yet, this itinerary can be read also backwards to reveal its implicit political trajectory. Starting from the end, Marx presents a standpoint theory of automation (section 15.5 on 'The struggle between worker and the machine') within a labour theory of automation (chapters 14 and 15 on 'Machinery and large scale industry'), which is itself cast within a value theory of automation (chapter 12 on 'The concept of relative surplus value.'). Thus, while the economic analysis begins with capital, the political synthesis begins with the antagonism of labour. The following exposition follows being precisely following the reverse order of Marx's exposition in Part V of *Capital*.

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<sup>2</sup> For reasons of space, this text does not treat theories that, for instance, see the state as a main driver of innovation. As known, bureaucracy played a key role in the development of statistics (Foucault 1977/2009, Hacking 2015) and information retrieval (Agar 2003, Wiggins and Jones 2023). The army played a role in the development of technology as well, although some scholars claim that war has only accelerated existing technologies rather than establishing new ones. The martial a-priori was explored famously by Kittler (2021) whose theory has been exposed by Winthrop-Young (2002).

## PART I – Theories of automation since the industrial and colonial age

### 1. Standpoint theories of automation

Standpoint theories of automation see automation as driven by social antagonism and hierarchies of class, gender, and race, emerging from processes of subjectification that are simultaneously processes of resistance, refusal, and reappropriation (sometimes involving psychological identification too: see the position of hacker subcultures and cyborg philosophies). Standpoint theory comes from feminist studies, where it emphasizes subjectivity as an antagonistic and active force in knowledge production (Harding 1986, Gurung 2020). Obviously, one must consider here any form of political organization and subjectivity that rises and takes a 'stand.' These theories can be defined, in different ways, as social and antagonistic theories, as they focus on the role of the political subject rather than the economic structure. They could be rendered as biopolitical theories too, following the way some scholars, after Foucault (1988), have studied the production of subjectivities by technical apparatuses. Standpoint theories of automation stress the effect of labor resistance and unionization on investments in automation, and in this vein one should not forget the impact of migrations (Mezzadra 2011).

Marx (1867/1981: 552-553) famously stated that machinery 'is the most powerful weapon for suppressing strikes' and that 'it would be possible to write a whole history of the inventions made since 1830 for the sole purpose of providing capital with weapons against working-class revolt.' Historians such as Eric Hobsbawm (1952) and E.P. Thompson (1963) have rescued the movements of machine breakers such as Luddism from the accusation of technophobia and showed their role in a novel class composition. In fact, already in the 19th century, the machine was a locus of social struggle, as Maxine Berg (1980: 10) reminded us in her book on the Machinery Question: 'The very technology at the basis of economy and society was a platform of challenge and struggle. The machine was debated at length in all sectors of society. It provoked the village cleric as much as it did the cosmopolitan intellectual; it concerned the politician as much as the workman and employer; the social reformer as much as scientist and inventor.'

In the 20<sup>th</sup> century, Italian *operaismo* initiated a critique of the neutrality of technology in production (Panzieri 1961) and pushed for another position: it viewed labour struggles as a primary and not secondary actor in capitalist innovation. In the journal *Classe Operaia*, Mario Tronti (1964/2019: 65) famously advanced a Copernican turn in class theory: 'We too saw capitalist development first and the workers second. This is a mistake. Now we have to turn the problem on its head, change orientation, and start again from first principles, which means focusing on the struggle of the working class. At the level of socially developed capital, capitalist development is subordinate to working-class struggles; not only does it come after them, but it must make the political mechanism of capitalist production respond to them.' More recently, Antonio Negri and Michael Hardt (2017) have advocated the 'appropriation of fixed capital' considering that the border between human and machine is difficult to trace: 'Instead of rejecting technology, then, we must start from within the technological and biopolitical fabric of our lives and chart from there a path of liberation. [...] Our intellectual and corporeal development are inseparable from the creation of machines internal and external to our minds and bodies. Machines constitute and are constituted by human reality' (Hardt and Negri 2017: 106, 109).

Autonomist feminists such as Silvia Federici (2019) have contested such an optimistic view and sees emancipation only outside the sphere of technology, moving from the observation that domestic and care labour has been barely automated. Along similar lines, authors from Ruth Schwartz Cowan (1983) to Astra Taylor (2018) have extended the sphere of automation to include domestic and reproductive work revealing that that automation made women work more, not less. Shulamith Firestone (1970) and Donna Haraway (1985), on the other hand, have advocated for women's emancipation through technology. More recently, Neda Atanasoski and Kalindi Vora (2019) have shown how the dreams of full automation (which include AI) are grounded on the 'surrogate humanity' of enslaved, servants, proletarians, and women, that make possible, through their forced or invisibilised labour, the universalistic ideal of the autonomous (often white and western) subject (see also Gray and Suri 2019, Benjamin 2019, Munn 2020).

## 2. Labour theories of automation

Labour theories of automation explains its development from the perspective of the material logic of production and the division of labour, or labour process, rather than the standpoint of subjectivities.<sup>3</sup> Adam Smith was the first to sketch a *labour theory of automation* in *The Wealth of Nations* (1776) by recognising that machines are 'invented' mostly by imitating the organisation of tasks in the workplace: 'The invention of all those machines by which labour is so much facilitated and abridged seems to have been originally owing to the division of labour.' Hegel's notion of **abstract labour**, as labour that gives form to machinery as well as social institutions, was indebted to Adam Smith, who Hegel commented already in his Jena lectures (1805-06). Nevertheless, it fell to Babbage to systematise Adam Smith's insight in a consistent labour theory of automation, that he exposed in his popular manual *On the Economy of Machinery and Manufactures*:

Perhaps the most important principle on which the economy of a manufacturer depends, is the *division of labour* amongst the persons who perform the work [...]. The division of labour suggests the contrivance of tools and machinery to execute its processes [...]. When each process has been reduced to the use of some simple tool, the union of all these tools, actuated by one moving power, constitutes a machine. (Babbage 1832: 131–6)

Marx adopted the labour theory of automation in Part IV of *Capital* and had already discussed it in the *Grundrisse*, where he stressed that the road to technological innovation usually is not the analysis of scientific laws and their subsequent application to production: 'This road is, rather, analysis [*Analyse*] – through the division of labour, which gradually transforms the workers' operations into more and more mechanical ones, so that at a certain point a mechanism can step into their places' (Marx 1848/1993: 704, translation modified).

When Babbage wrote that 'the division of labour suggests the contrivance of tools and machinery to execute its processes', it meant that *the design of the division of labour shapes the inner design of technology*. The spontaneous intelligence of the cooperation of labour gives form to automation first, rather than the other way around. Babbage complemented this theory with the *principle of labour calculation* (that Braverman 1974 termed the '**Babbage principle**') to indicate that the division of labour allows another key function: the precise computation of the costs of labour and resources.

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<sup>3</sup> Other theories see the state as a driver of innovation. Bureaucracy played a key role in the development of statistics (Foucault 1977/2009, Hacking 2015) and information retrieval (Agar 2003, Wiggins and Jones 2023). The army played a role in the development of technology as well, although some scholars claim that war has only accelerated existing technologies rather than establishing new ones. The martial a-priori was explored famously by Kittler (2021) whose theory has been exposed by Winthrop-Young (2002).

The master manufacturer, by dividing the work to be executed into different processes, each requiring different degrees of skill and force, can purchase exactly that precise quantity of both which is necessary for each process; whereas, if the whole work were executed by one workman, that person must possess sufficient skill to perform the most difficult, and sufficient strength to execute the most laborious, of the operations into which the art is divided. (Babbage 1832: 137)

In short, the division of labour is an instrument of measurement and implicit metric of labour, dividing the workforce in classes of skill and therefore salary. Babbage's vision of management had clearly a disciplinary nature, that Meredith Whittaker (2023) and James Muldoon and Boxi Wu (2023) trace back to the discipline of enslaved workers in the colonial plantations. Many scholars have stressed the similarity between surveillance and discipline in the plantations and techniques to measure and organise labour in the industrial factories (Adas 1989, Mirzoeff 2011, Browne 2015, Fiori 2020). Silvia Federici (2004) predates this phenomenon to early modernity: she argues that the rise of modern rationality and mechanical worldview was related to the transformation of women's bodies and the collective body into a docile and productive machine. In other words, social relations became an abstract machine before the regime of industrial capitalism turned them into actual machines.

As known, the labour theory of automation inspired the early projects of **computation**. Babbage maintained the two principles of the division of labour as a cornerstone of his 'calculating engines', such as the *Difference Engine*, prototype of the modern computer (Daston 2018). He was inspired by the French mathematician Gaspard de Prony who had the idea of applying Adam Smith's principle of the division of labour to hand calculation of logarithmic tables. Babbage took De Prony's algorithm, known also as 'method of difference', and sought to embody it into the mechanism of the Difference Engine. In synthesis, computation was born as the automation of the division of mental labour.

Babbage's intuition was later revived by key pioneers of computation such as Turing (1950) and Simon and Newell (1958) who openly acknowledged the influence of labour management on Operation Research and AI as well (cf. Daston et al. 2015: 42). The most acute reader of Babbage's theory of the division of labour in the 20<sup>th</sup> century remains Harry Braverman, whose influential book *Labour and Monopoly Capital* (1974) initiated the labour process and deskilling debate (Smith 2015). Braverman rediscovered and named the 'Babbage principle' (Bellamy Foster 2024) and brought attention in particular to the relation between his experiments in computation and political economy, influencing later scholars in the field of history of science (Daston 1994, 2018; Schaffer 1994).

Braverman extended his critique of Babbage to the Taylorism of the 20<sup>th</sup> century and highlighted how scientific management constituted a technique of **knowledge extraction** and alienation. He identified three principles of Taylorism: 1) *the dissociation of the labour process from the skills of the workers*; 2) *the separation of conception from execution*; 3) *the use of the monopoly over knowledge to control each step of the labour process*.<sup>4</sup> Criticising these principles, Braverman aimed at recognizing the role of cooperative labour and the spontaneous intelligence of workers also in the development of innovation and scientific abstractions. With a perspective close to historical epistemology of science (see Boris Hessen 1931), Braverman argued that industrial science did not help automation, rather labour organisation did. Against the myth about the role

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<sup>4</sup> *The dissociation of the labour process from the skills of the workers* ('The managers assume... the burden of gathering together all of the traditional knowledge which in the past has been possessed by the workmen and then of classifying, tabulating, and reducing this knowledge to rules, laws, and formulae', Taylor 1911: 36). *The separation of conception from execution* ('All possible brain work should be removed from the shop and centered in the planning or laying-out department', Taylor 1903: 98). *The use of the monopoly over knowledge to control each step of the labour process*. ('Perhaps the most prominent single element in modern scientific management is the task idea. The work of every workman is fully planned out by the management at least one day in advance, and each man receives in most cases complete written instructions, describing in detail the task which he is to accomplish, as well as the means to be used in doing the work', Taylor 1911: 39).

of science in industry, Braverman (1974: 155) brought the canonical example of the steam engine, which prompted the development of the science of thermodynamics rather than the other way around.

A decade earlier, In the debates of Italian *operaismo*, Romani Alquati made a similar critique of scientific management and went to recognise **information** as a key element that workers themselves produce within the factory. During militant co-research (*conricerca*) at the Olivetti computer factory, one of the first in the world, Alquati distinguished two flows of information in the production processes: 'control information' and 'valorising information' (Pasquinelli 2015). The former is the information (we could say knowledge) appropriated by industrial and bureaucratic apparatuses to control production, the latter is the information produced by workers through the continuous micro-decisions and measurements that give shape and value to the final product. As Alquati put it:

Information is essential to the labour force, it is what the worker—by means of constant capital—transmits to the means of production on the basis of evaluations, measurements, and elaborations in order to effect on the object of work all those changes of form that give it the required use value. (Alquati 1963: 121, trans. mine)

Aside from the two types of control and valorising information (both operative forms of information), Alquati also distinguished information crystallised in bureaucratic apparatuses and archives (such in databases) and information objectified in methods, techniques, and machines (Alquati 1975: 130). This kind of information that is formalised in techniques and embodied in databases has constituted the repository of codified knowledge that will prepare the terrain for the rise of AI in the following stage of automation. However, in the early 1990s Italian *operaismo* reignited the debates on knowledge workers and went back 'to enlarge the notion of general intellect far beyond the kind of knowledge which is materialized in fixed capital, to include also those forms of knowledge which structure social communications and which impel the activity of mass intellectual labor. The general intellect includes artificial languages, system and information theories [...]' (Virno 1990/1996, translation modified).

### **3. Metric theories of automation**

The Babbage principle sees the division of labour as a structure of relations to be reorganised but also as a means to measure labour: the division of labour becomes, as a matter of fact, an instrument of measurement and computation. An optimal disposition of tasks is an implicit measure of each task in terms of wage, time, energy, and resources that are required for production. It should be repeated that measures are not airborne and imposed from above, such as by science for instance, but they are part of long political negotiations and economic dynamics (Kula 1986) and one can easily envision such negotiations in the forming and adoption of new machines. The clock, for instance, historically appears as the first metrics of labour in the industrial age and its discipline was not implemented without resistance. The clock can be seen as the first social machine of modernity, yet as Moshe Postone (1993: 212) noted, it was the new (and more abstract) temporal organisation of production and circulation in 14th century Europe that required the development of more exact clocks, not the other way around. In this sense, more efficient clockwork mechanisms emerged from the need to measure labour in a more abstract and precise way.

Other technologies of the industrial age such as steam engine and telegraph can be seen under this metric perspective. Norton Wise (1988), for instance, has proposed seeing both the steam engine and telegraph as ‘mediating machines’, as epistemic mediators between political economy and natural philosophy, between labour and science. The steam engine, for instance, played a twofold role in the measurement of labour and the consolidation of the metric unit of work in physics (Wise 1988, 77). In a similar way the telegraph imposed the first quantification of communication and encoding of language into a binary code (Pasquinelli 2022). This insight points to a common ground between value and labour in theories of automation, according to which technology is not only a means of production but, in fact, also an instrument for measuring production and its value. This perspective can be identified as a **metric theory of automation**, according to which techniques that are used to measure labour suggest also the design of new technologies of automation.

In synthesis, one can describe this historical process in this way: first, the division of labour becomes implicitly or explicitly an instrument to measure labour; second, new practices of measurement prompt the rise of new metrics and therefore a new metrology; third, these new practices of measurements influence in their own the design of new techniques of automation; fourth, a new technology is a new configuration of space, time, and social relations, and implicitly projects new metrics of such dimensions. In this dynamics, one should acknowledge that workers’ resistance affects the measure of labour and its division, influencing therefore also the design of automation that emerges in this process. The metric theory of automation, then, can be used as a prism to pursue a further integration of labour theories, social theories, and value theories of automation.

#### **4. Value theories of automation**

Value theories of automation explains automation as a process that capitalism steers from the outside, selecting those technologies that improve production and circulation. When Ramin Ramtin (1991: vii) wrote *Capital and Automation*, he found that ‘although the literature on automation is certainly extensive, there is a clear gap in that which deals with the issue of automation from the perspective of a Marxian value theory.’ According to Ramtin, technology has to be understood from the point of view of the value form that capital impresses on it as a seal. Following Marx’s canonical lesson in Part IV of *Capital*, Ramtin stressed that the purpose of capitalist technology is not to raise the quantity of output but the extraction of relative surplus value: ‘The ultimate test of any technology of production under capitalism is its actual power to increase surplus labour-time relative to necessary labour-time. However, this social aspect of the ‘measure’ of the development of technology is translated into technical features’ (Ramtin 1991: 3). If ‘measure becomes a technical feature’, this means that the measure of value forges the design of the machine as its instrument.

In this top-down perspective, capital is not the mother of invention: technological innovation usually happens via Research and Development units where capital directly subsumes scientific work. As Mandel (1975: 252) highlighted in *Late Capitalism*, it was during the 20<sup>th</sup> century boom that ‘invention had become a systematically organized capitalist business.’ In the Schumpeterian variants of this perspective, often popular also in Marxist circles, capital remains agnostic to the design of technology: technological development occurs according to its own logic and only thereafter capitals adopt the most fitting innovations through a process of ‘selection.’ This is the particularly case also in the account of new sources of energy in the industrial age. Andreas Malm (2013, 2016) has stressed that coal won over water as an energy source for mills, because the abstract quality of coal was ‘selected’ by the new regime of abstract

labour: steam engines allowed factories to move close to urban areas and establish a clockwork discipline: 'The steam-engine won out over water-powered mills in nineteenth-century British industry not because it was cheaper or more productive, but because water technologies were incompatible with competitive relations among firms and the antagonism between capitalists and workers' (Mau 2023: 236).

Other value theories, however, see economic cycles independent from automation. In a tradition that runs from Brenner's *The Boom and the Bubble* (2002) to Benanav's *Automation and the Future of Work* (2020) and Smith's *Smart Machines and Service Work* (2020), it is the fall of profit and investments to cause underemployment, not automation per se. In this reading, 'robots won't steal your job', because stagnation has already eroded the ground for production. Matthew Cole (2025: 1) has criticised this view of stagnation, arguing that 'these approaches misdiagnose the problem, replacing technological determinism with economic determinism. Further, they misinterpret the recomposition of global capitalism and labour institutions while neglecting class struggle.' According to Cole, de-industrialisation had produced dynamism in the service sector and new forms of automation such as AI, whose economic rationale may contribute at the end to stagnation but whose dynamics has yet to be explained. Cole sides with Acemoglu and Restrepo (2019) who advance a more complex model and identify three effects of technological change. The *displacement effect* is the substitution of machines for human labour, fuelling both fears of unemployment and hopes of a work-free society. The *productivity effect* lowers production costs and prices, stimulating demand for goods and labour. The *reinstatement effect* offsets displacement by generating new tasks and demand for new skills.

Value theories of automation exist also in a radical version that attempts to build an epistemology of technology in a similar way as Alfred Sohn-Rethel (1970/1978) did once trying to see an epistemic effect of the money form on the rise of Greek philosophy. Jonathan Beller (2021) and Seb Franklin (2021) argue that the abstraction of the value form, rather than the abstraction of labour, is what has influenced the form to information technologies, or digitality.

## 5. Towards an organic theory of automation and AI

In synthesis: in the capitalist mode of production, the machine has come to crystallise a social order, an organisation of labour, a technique of measurement, and an economic diagram. In short, a form of subjectivity, a labour form, a metric form, and a value form. These four dimensions are deeply imbricated. In capitalism's logic, any increase in profit extraction implies a tighter division of labour. Any tighter division of labour implies a vertical division of labour that is a social hierarchy of skill. Any hierarchy implies a metrics. Any metrics implies previous conflicts and negotiations around cultural and economic values. Quantification of labour appears to be the road to automation, that, in its own, engenders and expands novel social metrics of labour. One should consider whether, at the end, the very nature of capitalist technology is but measure and hierarchy. But in a different mode of production, the machine could be the crystallisation of a different set of social relations. It could be the crystallisation of an economic diagram in which the calculation of labour and its organisation would govern by other principles.

## PART II - AI from the perspective of automation theory

The first part outlined major theories of automation, attempting an organic theory to comprehend the forms of subjectivity, labour, measure, and value that operate together in the modern history of automation.

Following their development, the second part analyses these four aspects in the current predicament of AI: first, its social form: *microwork*; second, its labour form or form of management: *pattern analysis*; third, its metric form: *psychometrics*; and fourth, its value form: *eigencapital*. This fourth aspects should help sketching an organic theory of AI models from a sociotechnical and historico-materialist perspective.

### 1. The subjective form of AI: microwork

In the early digital age, in the 1980s, the *hacker* (Wark 2004) stood as the symbol of technological resistance, becoming later a metaphor at large for the cognitive worker of post-Fordism and basically anyone dealing with information machines. The hacker was a short-lived utopia of emancipation in the information age that was rapidly subsumed by the start-up mentality. With the rise of the corporate Internet in the 2000s, a different figure emerged. The first kind of worker native to the digital networks happened to be called 'turker.' This term, per se an orientalist stereotype, describes a freelance worker for the Amazon Mechanical Turk platform, who is hired to perform repetitive online tasks. Amazon CEO Jeff Bezos cynically define turkers 'Artificial Artificial Intelligence', since they are employed to automate tasks that automation fails to accomplish. Notably, Amazon Mechanical Turk played a big role in the making of the first dataset of deep learning ImageNet (Fei-Fei et al. 2009; Denton et al. 2021) and similar platforms are still used today to outsource AI's *ghost work* (Gray and Suri 2019) around the world. Eventually, the turker became the prototype for any *gig worker* of the platform economy, such as food delivery riders and Uber drivers (Moore and Woodcock 2021, Woodcock 2021). Today one could subsume all new types of online work as *microwork*. The release of ChatGPT in November 2022 can be interpreted as the symbolic end of the knowledge society paradigm: an optimistic worldview that was expecting to generate prosperity through knowledge's virtuous proliferation, while underestimating its proneness to automation. As it is becoming more and more clear, today workers already are forced to buy tokens of microtasks in order to be able to work: they are paradoxically requested to pay for automating part of their own work. The hacker, who aspired to be a cyborg or a cognitive worker, found herself as a microworker microtasking on the AI platforms of the vectorialist class (Wark 2019).

Microworkers and gig workers exemplify the precarious labour subjectivities and class composition of current AI. Their jobs are often 'bullshit jobs', as David Graeber (2018) called them, revealing the fraud of the promises of the knowledge economy and network society. These subjectivities remain antagonistic: today, the distinction between hacker, gig worker, and microworker is increasingly blurred as they all engage in acts of 'algorithmic resistance' (Bonini and Treré 2024). The resistance to dominant technologies has crossed the whole 20th century up to the hackers movement and so-called Neo-Luddism in the digital age (Mueller 2021, Bonin and Treré 2024, Sadowski 2025) and include recent forms of resistance against AI (McQuillan 2022, Bender and Hanna 2025). The rise of AI should be seen as part of a long process of deskilling and declassing of digital workers that traces back at least to the 2000 dot-com crash, which resulted into the proletarianization of the hacker and the making of a new *cyber-proletaria'* (Nick Dyer-Witheford 2015). This reserve army of digital workers and users has animated the alter-globalisation movements as well as generations such as the Arab Spring. One can suggest (as Antonio Negri among others did) that as much as the third technological 'revolution' of information technologies developed to contrast the resistance of social movements after WWII and new forms of socialised work, in a similar way the fourth technological 'revolution' of AI is directed to neutralise the aspirations of global movements and the new social composition of cognitive work.

## 2. The labour form of AI: social patterns

What is the structure of AI systems and what give form to them? Rather than repeating trite debates whether AI may be truly intelligent or not, a simple materialistic analysis of its infrastructure immediately reveals confirm the labour theory of automation that was expounded before. The AI infrastructure is composed as follows: (1) a planetary multitude of *microuers* or *microworkers* is connected via (2) a global digital network to (3) a centralised datacentre running (4) a large AI model that has been previously trained on (5) a vast dataset. The input of the AI pipeline is human labour, culture, social relations, and collective data in general (Muldoon et al. 2024), but one could say that the input and output of AI are the same: *microtasks*. Microtasks are what AI models extract and microtasks are what they automate.

AI models represent an ‘analytical intelligence’ of labour (Daston 2018) and they generate artefacts by imitating the social division of labour (that is key to performing any task, from composing an email to describing an image). In AI, it appears somehow as the structure of the division of labour, the structure of automation, and the structure of the commodity share a deep similarity. There is a structural isomorphism between labour, automation, and commodity form. From a philosophical point of view, there is no obstacle to state that the content of knowledge is an abstract relation, an organisation and disposition of the world. *All knowledge is a division of labour at large, a configuration of relations*. Nowadays, AI models can encode relations of any kind. They are termed in fact ‘multimodal’, as they can record correlations between artefacts as diverse as images and texts, for instance (see the generation of images by a simple prompt). This multimodal capacity blurs the distinction between artefacts, between image and text for instance. With AI all forms of knowledge fall in the same statistical structuralism of social relations (not to be confused with French structuralism). In synthesis, looking at its genealogy, its inner architecture, and its artefacts, one cannot but record that the constitution of AI is the global division of labour. The division of labour is the genealogy of AI—and, conversely, AI projects back on society a new division of labour, that AI orchestrates like a vast planetary automaton.

In *The Eye of the Master*, it was observed that the division of labour has become more and more complex through time, innervating into the social fabric outside the factory and organising into extended patterns of life. The consequence of this expansion is that also the techniques and instruments to trace and measure it have evolved. The old concerns of Time and Motion Studies turned into urban rhythm analysis (Lefebvre 1992/2004) and in trajectory analysis or *trajektology* (Brighenti and Pavoni 2023) that is used today to map movements of workers, drivers, and users in the gig economy. These dynamic social patterns and urban trajectories draw the outline of labour cooperation—the *Gesamtarbeiter* in the current mode of production. The power of current AI models is their capacity to trace and adapt to a global and flexible collective worker. Through AI, the division of labour has become the object of complex techniques of **patterns-of-life analysis** at the collective scale (which are, by the way, also common to the military: Chamayou 2015) and of **micro-intentions analysis** at a sub-individual scale (Chaudhary and Penn 2024).

[M]achine learning can be seen as the project to automate the very process of machine design and model making – which is to say, the automation of the labour theory of automation itself. In this sense, machine learning and, specifically, large foundation models represent a new definition of the Universal Machine, for their capacity is not just to perform computational tasks but to imitate labour and collective behaviours at large. The breakthrough that machine learning has come to represent is therefore not just the ‘automation of statistics’, as machine learning is sometimes described, but the automation of automation, bringing this process to the scale of collective knowledge and cultural heritage. (Pasquinelli 2023: 248)

### 3. The metric form of AI: psychometrics

The idea of 'knowledge society' often operated as a discriminatory paradigm, elevating a new 'labour aristocracy' in the same way that guilds celebrated skilled artisans during the industrial age. As Quinn Slobodian (2025: 94) observes, terms such as 'information age' and 'knowledge economy' began to circulate in the 1990s, at the same time when neoliberal elites were rediscovering the IQ test (a technique of psychometrics) as a means of class, gender, and racial discrimination. This moment was marked by the publication of *The Bell Curve: Intelligence and Class Structure in American Life* (Herrnstein and Murray 1994). This racist book argued that the IQ test demonstrates that class division is not historical but natural and motivated by ethnic background. The IQ test became, then, an alibi for neoliberal circles to justify low salaries for Black Americans and support the idea of 'intelligence hierarchies' or 'neurocastes' (Slobodian 2025: 93). Nonetheless, the IQ test was evidence of an economy supposedly based on the productive power of culture, science, and information, and yet in need of means of racialisation and social discrimination.

The measure of skill is key for the labour market to discriminate workers in different classes. Since the early 20<sup>th</sup> century, psychometrics (in the form of IQ test among others) has played the role of such social measure. Psychometrics belongs to the controversial legacy of Alfred Binet, Charles Spearman, and Louis Thurstone, and rose to dominance in US psychology departments in the 1950s, consolidating as a branch of applied statistics. Statistics itself has never been a neutral discipline. From its origins in state administration and eugenic policies, it has functioned as a technique of normalization (Foucault 1978): a means of defining the social 'average', calculating deviations and abnormalities, and regulating populations (Hacking 1990; Porter 1995; Desrosières 1998; Pasquinelli 2017). As Stephen Jay Gould (1981) showed in his important book *The Mismeasure of Man*, psychometrics emerged from the pseudo-science of craniometry and was deeply implicated in supplying the pseudo-scientific rationales for hierarchies of class, race, and gender.

It is revealing that the mathematical form of psychometrics (i.e. multidimensional analysis) is found also at the origin of the current form of AI, deep learning, which is an evolution of artificial neural networks. In the mid 1950s, Frank Rosenblatt developed the first artificial neural network Perceptron not simply by imitating the structure of biological neural networks (as widely repeated) but implementing techniques of linear algebra and multi-dimensional analysis that he, as a trained psychologist, adopted from psychometrics (Pasquinelli 2023: 205). The Perceptron was invented by implementing statistical techniques to automate the recognition of visual rather than psychological patterns.

The IQ test and AI are part of the same sociotechnical development in which the former operates as a social metrics and the latter as its technique of automation. If the statistical measurement of intelligence was instrumental to reinforce class, race, and gender discrimination, one cannot notice a structural similarity with the debate on social bias in AI today. It seems that the issue of class, race, and gender bias that affects AI datasets and models is a second (mechanised) reiteration of the old system of class, race, and gender discrimination that was implemented via psychometrics. AI bias is not a technical issue only but one deeply imbricated with the history of social metrics and techniques of discrimination (Benjamin 2019, Chun 2024). Although IQ tests started to be used in the US army and schools already in the early 20<sup>th</sup> century (Gould 1981), its revival today, in the neo-authoritarian culture associated with the alt-right and Silicon Valley, signals that the economic order of AI demands a social metrics to discipline population and workforce—in stark contrast with the promise of full automation and human emancipation that AGI would deliver.

#### 4. The value form of AI: eigencapital

AI's power relies on the scale of its collective formation, on the accumulation of labour and knowledge extracted from the global society and its automation into a vast statistical model as a *Gesamtarbeiter*. AI is tendentially a monopolistic technology, because its horizon of capture is the totality of cooperative labour, social communication, collective knowledge, and cultural heritage at a global scale. In similar terms, in the *Grundrisse*, Marx defined machinery as 'the accumulation of knowledge and of skill, of the general productive forces of the social brain' and 'the most adequate form of capital as such' (Marx 1858/1974: 694). But in which way is AI measuring and computing the overall field of collective knowledge? In AI system, it has been established that the measuring unit of collective knowledge is the *token* and the computing unit of tokens embedded in a multidimensional space is the *vector*. This essay is not merely concerned with the definition of *token* and *vector* in computer science, rather with their translation into political economy.

In a sort of Babbage principle expanded to a planetary scale, the monopoly of AI is constituted by the computation and accumulation of units of microtasks known as *tokens*, which become the basis for a novel calculus of relative surplus-labour known through *vector calculus*. In computer science, a token is a measuring unit of language and instructions that does not correspond to units of natural language but to how algorithms fragment it in the most economical way (Caffoni 2026). The token is also the cost unit of the microtasks that are automated by AI datacentres. Users send short prompts to AI models that are monetised in tokens and receive large outputs, that is microtasks, that are monetised in tokens as well. The number of users, their time spent on AI platforms, the number of automated microtasks, the cost per token, and the ratio of parameters per token define, among other factors, AI's economic dimension.

The value form of AI is what one could call *vector capital* (or *eigencapital*), understood not just as a form for the mechanisation of collective knowledge, but as a new form for the calculation of the productivity of labour, language, and culture at large. In economics, eigencapital has a different meaning (which will not be expanded here), but the rise of vector calculus and embedding in AI prompted scholars such as Fourcade and Healy (2016, 2024) to define eigencapital as a sort of general vector calculus of individual and collective data to define their ranking, value, and productivity in the 'ordinal society' (Fourcade and Healy 2024).

It might take the form of some vector of information that summarizes your situation and value across many features—something that compactly represents your position in the multidimensional space of classification situations. It would, in short, characterize your social location. In data analysis, this procedure often involves the decomposition of matrices of data into orthogonal eigenvectors, the better to characterize them. [...] From an individual's point of view, these quantities and their representations would be a kind of resource. Call it eigencapital. (Fourcade and Healy 2024: 117)

Training datasets project collective knowledge as data points in multidimensional space, while the model attempts to build a stable representation of them through vector embedding and linear algebra. This technique is not new neither in economics, where it is used to calculate *eigenvalues* and *eigenvectors* of economic data, nor in the sociology of knowledge, as Pierre Bourdieu already advanced 'geometric modelling to quantify the basic dimensions of social space and explore sociological hypotheses' (Lebaron 2009: 13). The making of AI models is a form of automation in which metaphorically one could say that *vectors replace workers*, as vectors ultimately calculate the many variables of labour cooperation and its spontaneous intelligence. Marx first proposed the idea that the division of labour performs a sort of a mathematical equalisation of the collective worker:

The division of labour under the system of manufacture not only simplifies and multiplies the qualitatively different parts of society's collective worker, but also creates a fixed mathematical relation or ratio which regulates the quantitative extent of those parts - i.e. the relative number of workers, or the relative size of the group of workers, for each special function. Thus alongside the qualitative articulation, the division of labour develops a quantitative rule and a proportionality for the social labour process. (Marx 1867/1981: 465)

This insight can be easily extended to the genesis of the structure of machinery. As Kenji Mori (2019: 317) noted: 'According to Marx's understanding about the principle of multiples [...], the machinery system would be appropriately understood as a 'mathematically fixed' vector of physical and labour inputs around which particular cases may be perturbed randomly.' Similarly, from a mathematical point of view, the vector capital or eigencapital of an AI model could be defined as the equalisation of all the data points projected on its vector space, more specifically, as the ratio between AI model parameters and the dimension of the dataset. This ratio, that is the equalisation of social variables into a model, points to something about the constitution of fixed capital that in previous stages of automation remained unclear. This ratio, as Marx hinted, is an index of the transformation of living labour into dead labour—today, of living knowledge into machine knowledge. The idea of a vector capital or eigencapital in AI is a quantitative one: it is about the calculation of relative surplus value, in this sense quite different from qualitative notions such as cultural and cognitive capital.

Vector capital is the value form of AI monopoly, yet a very dynamic and volatile one. Given the turbulent ecosystems of data extractivism, AI business is based on a **differential monopolistic rent** that runs along and competes upon the dynamic valorisation of knowledge. The concentration of collective knowledge and cultural heritage in AI models represents a new dynamic form of knowledge rent that surpasses the previous (and temporary) dominion based on intellectual property rights (Durand 2020, Rikap 2021) and extend the first forms of knowledge extractivism inaugurated by algorithms such as Google's PageRank that stated already in the 1990s to build vast datacentres (Pasquinelli 2009). AI models attract investments because of the acceleration of this concentration, because of the gradient of their differential rent on collective knowledge. AI models and datacentres represent a new economic configuration and evident scale shift: whereas industrial machines were a crystallisation of specific division of labour and forms of knowledge, AI models are a dynamic modelling of collective knowledge and division of labour at a global scale.

The globalisation of information technologies and the formation of new technological monopolies in the 20th century, in fact, has brought attention to another value form rather than profit: monopoly rent. Mandel (1975: 252) already noticed that: 'in accordance with the logic of late capitalism, [...] technological rents have become the main source of surplus-profits.' Rent is key to understanding the economy of information technologies including AI, as their market and workforce are immediately global. Technological rent is linked however to crisis: 'the absolute inner limit of the capitalist mode of production [lies] in the fact that the mass of surplus-value itself necessarily diminishes as a result of the elimination of living labour from the production process in the course of the final stage of mechanization-automation' (Mandel 1975: 207).

### PART III - AI in the long wave of economic cycles

The historical overview of automation theories help understanding the macroeconomic dynamics of technological cycles in the long run, in which one should also frame AI as part of the 'long century' of knowledge automation that started at least since the industrial age. Shifting from a synchronic to diachronic perspective, the third part engages with the *long wave theory of capitalist development* and specifically with Ernst Mandel's critique of it. The third part moves from a reading of Marx's formula of the rate of profit as a prism to read labour and technical composition together and extends Mandel's insight to study the rise (and potential collapse) of AI social order.

#### 1. Historicising the organic composition of capital.

The organic theory of automation is an attempt to make a synthesis of the various theories of automation that are employed in critical theory and history of science and technology. This synthesis, however, has to be set in motion and studied within the historical dynamics. A way of doing so is to consider another idea by Marx, that is the *formula of the rate of profit* and the notion of *organic composition of capital*. Despite its imprecise formulation and the confused literature that followed as pointed out by David Harvey (1982: 126, 207) and Alfredo Saad-Filho (1993), the formula of the rate of profit is here deployed to illustrate the mediation of technology in the antagonism between labour and capital. This formula helps to read the rate of profit (that is also the rate of labour exploitation) as the proportion between surplus value and the sum of constant capital (machinery and raw materials) and variable capital, that is human labour.

$$\begin{array}{c} \mathbf{p} \\ \text{rate of profit} \end{array} = \frac{\begin{array}{c} \mathbf{s} \\ \text{surplus-value} \end{array}}{\begin{array}{c} (\mathbf{c} + \mathbf{v}) \\ \begin{array}{cc} \text{constant capital} & \text{variable capital} \\ [\supset \text{machinery}] & [\supset \text{labour}] \end{array} \end{array}}$$

Fig 1. Formula of the rate of profit based on the organic composition of capital.

Within a capitalist dynamics, the formula of the rate of profit is usually interpreted as follows: the more AI is introduced in production, the more workers are replaced, the less surplus value then is extracted, therefore the rate of profit falls. Yet this movement can take a different turn. When AI is introduced, indeed workers are replaced, but new skilled and unskilled workers may be required and employed, more surplus value then is extracted, therefore the rate of profit grows. AI first replaces then displaces and may multiple workers. However, when AI saturates the sphere of production and circulation with its applications and artefacts, the market stagnates, surplus value falls again and so does the rate of profit. This is a common interpretation that, however, overlooks social autonomy and agency. The formula can also help see, in fact, how workers' resistance raises the cost of labour and, therefore, force capital to develop new technologies of automation such as AI, which replaces workers in the short run but displaces them to new jobs in the long run. At the end, the formula seems to describe not a fall but more like a cyclical development. Important: the fall of the rate of profit has be read in different ways in different economic systems. In a competitive economy, it is an indicator of crisis, but in non-competitive economies it may not. Even Adam Smith (Arrighi 2007: 46), for instance, interpreted it as a redistribution of wealth.

## 2. Long wave theory after Mandel

In his influential book *Late Capitalism* and in a following one specifically on the topic, Ernest Mandel (1975, 1995) revisited the long wave theory of capitalist cycles that was introduced by the Soviet non-Marxist economist Nikolai Kondratiev (1922/2004) yet influenced by Marx's reading of the organic composition of capital. Already Lev Trotsky (1923) had criticised Kondratiev for providing an endogenous theory and advanced his own exogenous interpretation in which economic cycles are not driven by internal dynamics such as the fluctuations of the financial markets but mostly by external factors such class struggle and international wars. It was Joseph Schumpeter (1939) to canonise the long wave theory and name its cycles as 'K-waves' to credit Kondratiev. In particular, Schumpeter consolidated the idea the economic cycles are tied to technological innovation. Mandel (1975/1995) then explored a position in between Schumpeter and Trotskii, maintaining however an externalist reading of economic cycles, in which exogenous factors (social struggles) are more influential than endogenous factors (financial dynamics) in driving technological innovation and economic growth.

In this reading of the role of technology, Mandel (1995: 29) stressed that technological cycles are not autonomous but bound to the economic and political cycles. He principally followed Marx's theory of automation: it is not science to drive technological innovation but the management of labour to inspire the design of new machines. This is a key passage worth to be repeated: information technologies and AI are often described as one of the main drivers of the economic cycle, while they should be seen as expression of a new social order and division of labour across society. Mandel, in fact, did not see technology as separated from its organic division of labour. This is a key point to keep in any theory of automation that aims at being systemic: 'Each specific technology, radically different from the previous one, is centered around a specific type of machine system, and this, in turn, presupposes a specific form of organization of the labor process' (Mandel 1995: 33). According to Mandel, machines operated by craftworkers were followed by machines operated by machinists and these by assembly lines involving deskilled workers: one can envision the phylum of these machinic assemblages evolving up to the age of information and AI. However, 'the transition from one to another has historically involved serious working-class resistance' (Mandel 1995: 33). 'In order to drive up the rate of profit to the extent necessary to change the whole economic climate, the capitalists must first break the organizational strength and militancy of the working class in the key industrialized countries' (Mandel 1995: 88). The design of new technologies, their shaping of the division of labour, responds indeed to the need by capital to break down the resistance of the working class and divide not just labour but social relations under a new discipline.

[E]ach of these revolutions in labor organization, made possible through successive technological revolutions, grew out of conscious attempts by employers to break down the resistance of the working class to further increases in the rate of exploitation. The first technological revolution was clearly an answer to the struggle of the British workers to shorten the normal workday. Marx himself commented on this at length in *Capital*. The second technological revolution was closely related to the increasing resistance of the strong crafts unions, both in the United States and in Western Europe, to more direct control by management over the work process; in fact, Taylorism arose directly out of the attempts to impose such direct control. Likewise, the third technological revolution had a direct link to the growth of unionization among semiskilled mass-production workers and to the need to whittle away the power of control over conveyor-belt production made possible by union strength of that type. (Mandel 1995: 35)

As just mentioned, Mandel's theory of the long waves of capitalist development is a synthesis of inter-economic and extra-economic dynamics. More specifically, for Mandel, crisis is driven by endogenous factors (such as financial crises), while growth by exogenous factors, such as class struggle: 'the downturn (the passage from an expansionist long wave into a depressive one) is endogenous, whereas the upturn is not, but rather is dependent on those radical changes in the general historical and geographic environment of the capitalist mode of production that can induce a strong and sustained upturn in the average rate of profit' (Mandel 1995: 42). Against both techno-determinism and economicism, Mandel recognised that the cycle of social struggles is 'relatively autonomous' from the technological and economic cycles. (Mandel 1995: 37, 42). To explain this thesis Mandel used a graph in which the cycle of class struggle (calculated as number of strikes per year) is relatively asynchronous with economic growth: 'We assume that there is a long cycle of class struggle [...] that is relatively independent of the long waves of more rapid accumulation and slower accumulation, although to some extent interwoven with them' (Mandel 1995: 39, fig. 2).

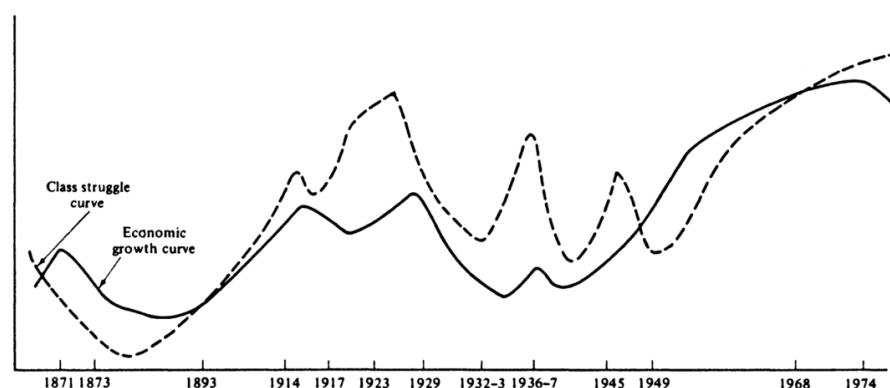


Fig 2. Long waves in European class struggle and economic growth (Mandel 1995: 39).

Mandel recognised that a variety of external 'system shocks' are crucial for ending an economic depression and starting a new wave of expansion, including: shifts in consumption, changes in labour organization, outcomes of social struggles and strikes, fluctuations in the labour supply due to migration, monetary hegemony, wars and revolutions, the expansion and contraction of credit, and shifts in core-periphery relations (Mandel 1995: 116-117). In synthesis, long wave cycles sees a dialectical relation between cycles of social struggles, cycles of technological innovation, and cycles of capitalistic growth and crisis. The quantitative study of working class conflicts and political organisation will be continued by Giovanni Arrighi and Beverly Silver (1995; 1999). Silver (2003) in particular initiated the World Labour Group Database with the purpose to bring statistics of social conflicts social within economic analysis. Hardt and Negri (2000: 238), however, criticised Arrighi (1994) for seeing cycles of social struggles as reactive rather than active in the unfolding of global economic cycles.

These reflections remain valid today as the long wave theory influenced a key framework of the 20<sup>th</sup> century governance such as *The Limits to Growth* report (Meadows et al. 1972) and indirectly also the Anthropocene debate. The report relied on a computerized world model developed by Jay Forrester (1971) that, reflecting a cybernetic worldview, stripped social agency from economic analysis and contributed to turning the cyclic model into an asymptotic curve, in this way grounding the Great Acceleration studies (Steffen et al 2004, Engelke and McNeill 2014) and promoting a vision of world dynamics driven primarily by technological forces only. To remedy such a shortcoming, Jürgen Renn (2024) has recently suggested adding the ergosphere, or the sphere of labour and knowledge production, to the Anthropocene world model composed by geosphere, biosphere, and technosphere.

### 3. Model collapse: AI in the long wave

A further exploratory hypothesis of this essay is that the form of technology, in its internal design or framework, do not mirror only the form of the division of labour but the whole economic dynamics and its social antagonism. The labour theory of automation has to evolve into a value theory of automation. This is particularly evident in the case of AI, if one consider the phenomenon of model collapse that can be envisioned also as a diagram of valorisation (and conceptually display many similarities with Marx's formula of the falling rate of profit).

Is the cycle of AI about to repeat the pattern of past technological cycles? According to the previous overview, AI seems to follow the same genesis of other technologies and to confirm, in general, the theory of automation as consolidated since Babbage, Marx, and the political economy of the 19<sup>th</sup> century. It seems, however, that AI marks a new phase in the history of automation. AI appears to be the automation of the automation principle itself, that is the automation of the labour theory of automation. This is evident in the current architecture, in which AI models dynamically adapt to different training data and can perform multimodal automation. The multimodal capacity makes AI the general-purpose technology (GPT) *par excellence* in the long history of economic cycles. This capacity to automate the principle of automation itself, however, disclose also a new kind of intrinsic limit: AI seems to automate not only the principle of automation but also its crisis, if one consider the isuse of model collapse.

Like any piece of machinery, AI models experience obsolescence. The turnover seems quite rapid. Models from a few years ago are replaced by new ones and quickly lose value. But AI models feature a technical kind of deterioration known as model collapse. Model collapse is the declining performance of generative AI models when they are trained not on genuine data but on content that has been generated by AI itself (after being published on the web and incorporated into training datasets: Shumailov et al. 2024). Model collapse is also termed 'model autophagy', as the model is 'eating' its own data or 'slop' in a recursive loop that degrades its statistical resolution.

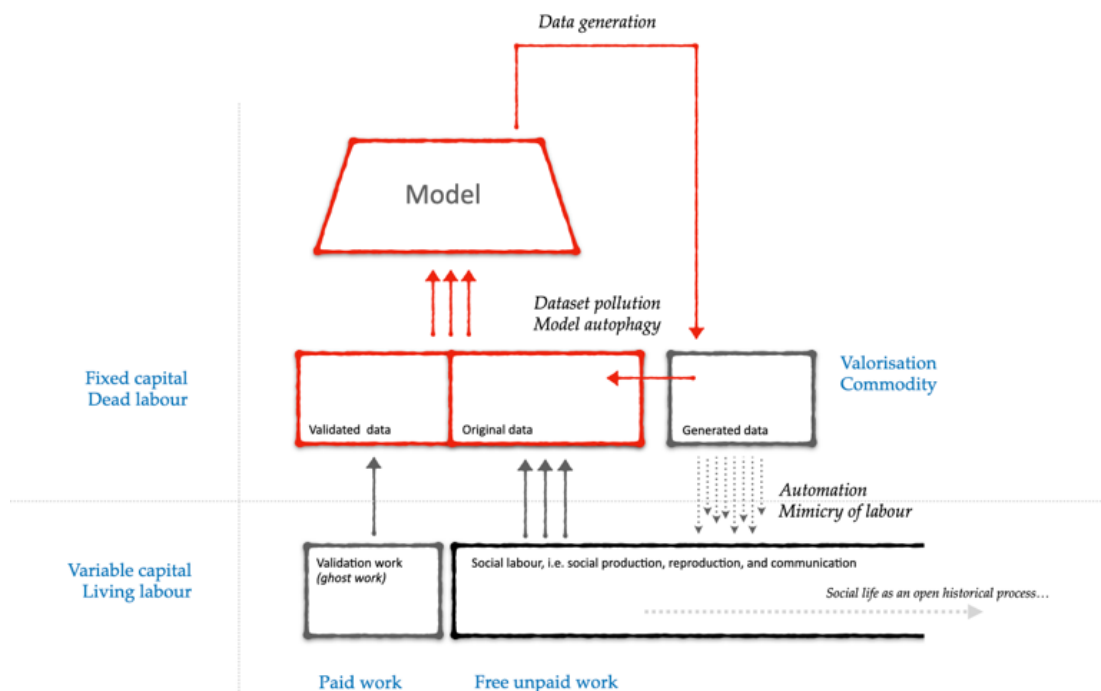


Fig 4. Model collapse from the perspective of political economy

Let's consider the case of Large Language Models (LLMs). They encode human knowledge from canonical corpuses of books as well as spontaneous sources such as websites, forums, and chats. They excel in translation and in reproducing knowledge of past archives (in fact they are provided with a cut-off date, as they are updated about events and publications until a specific date only). But the output is often regurgitated online polluting the future sources that will be used to train them and causing a loss of linguistic and semantic diversity. This means that, in the future, AI companies and media companies in general will eagerly search for original data from sources that have not been contaminated by AI itself. AI is causing, in this sense, an **economy of scarcity**, valorising all cultural heritage that has not been corrupted by generative AI. The release of ChatGPT in November 2022 can be taken, then, as a watershed date between the 'original' pre-AI cultural heritage and post-AI cultural production that is potentially corrupted by AI artefacts and their statistical normalisation. Similar phenomena happened in any media revolution since printmaking, yet the novelty of AI is that *the dissemination of machine artefacts may affect the design of the machine itself recursively*.

As much as AI recapitulates the global history of automation, in the same way it seems to encapsulate its degradation and depreciation. Under this respect, in between making and unmaking, growth and crisis, AI becomes a mirror of larger dynamics of the economic cycle. The political question, then, becomes how to govern a vast infrastructure that develops in an unstable symbiosis with the global society.

Aside from being a technical issue and endogenous limit only, model collapse should be interpreted also as an exogenous limit in a larger socio-economic perspective. Model collapse points to a socio-economic limit of any apparatus of automation ('the human in the loop' issue) and eventually it provides a tangible analogy and evidence for the crisis of automation. A sort of 'model collapse' always existed in automation as degradation of its design in the continuous tension to capture the multiplicity of living labour. As seen earlier in Mandel's criticism of the long wave theory and the synthesis of automation theories, the antagonism of labour is what often triggers a new wave of automation and keep it alive. As soon as a new division of labour emerges throughout society, technology has to adapt and evolve in order to capture it. However, this process is never linear and complete, but spurious and conflictive. Similarly, AI models strive to adapt to the generation of new forms of social life and they have to be fed continuously with fresh data to provide an updated picture of the collective mind and the collective worker. In short, any form of automation (including AI) is never autonomous and maintains a critical dependency on the evolution of society and living labour.

Finally, the evolution of LLMs has to be read in a broader geopolitical and geocultural perspective. AI is part of a common tendency of digital capitalism towards the formation of monopolies. Although they can assure incredibly high rents, monopolies affect competition and engender stagnation. One can take, once again, ChatGPT as a paradigmatic example of this tendency. It is specifically ChatGPT to represent the final stage in the parable of information technologies from the Global North that, with Claude Shannon, started as a statistical modelling of the English language. More precisely, the rise and collapse of information technology into AI, from Shannon's Printed English to Large Language Models, from WWII military cryptography to drone warfare, follows very closely the parable of the United States hegemony. US cultural hegemony reaches the historical limits of its sphere of influence with the imposition of Global English as lingua franca, whose peak and downfall, at the same time, is represented today by Large Language Models such as ChatGPT and their powerful capacity for translation and text generation in all idioms. A mirror of the global economy in stagnation, LLMs are increasingly struggling to generate consistent outputs due to

the phenomenon of ‘model collapse’ illustrated above. This inflation and degradation of the training data points to a scarcity of living labour that is required constantly to make AI look ‘intelligent’ and valuable, in a way similar to the dynamics of economic and technological cycles analysed by Mandel. The collapse of LLMs can be taken as a metaphor of the crisis of knowledge extractivism and the global trade system as a whole, to which the US administration is responding, not by chance, with neocolonial tariffs. and a new authoritarian culture). The rise of AI with Chinese characteristics, that is based on state monopoly on data production, provides a different point of view on these vast historical transformations.

In synthesis. It is not an exaggeration to argue that the social order of AI has entered a phase of decline, partly due to the crisis of techno-monopolies in the West. Economies in decline, after all, tend to generate their monsters—military expansion, authoritarian culture, and toxic personalities. Through the fissures of this collapsing system, however, alternative futures glimmer, as anti-war, anti-colonial, and anti-authoritarian movements have recently shown. At the end of this complex excursus, it is worth remembering Mandel’s late reflections regarding the role of political organisation and social movements within the long term dynamics of capitalism. At the conference ‘The Long Wave Debate’ in Brussels in 1989 (Verspagen 1989), he summarised his position against the fatalism of any economicist interpretation of history in this way — his words still resonate timely for today’s Europe:

To bring the controversy to its vital implication: is the class struggle cycle mechanically determined by economic forces resulting essentially from levels of employment (i.e., from fluctuations in the reserve army of labor)? Do long-term depressions make crushing defeats of the working class unavoidable? Was Adolf Hitler’s victory in 1933 inevitable? Or should one rather say that there is indeed a relative autonomy of long-term class struggle results, a relative desynchronization of the class struggle and the ups and downs of investment, output, employment and income? Can the subjective factor in history... make a decisive difference between victory and defeat of, for example, fascism? (Mandel 1995: 114)

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