Artificial Intelligence and the Contradictions of Capitalism: A Marxist Analysis

History, Current Dynamics and Perspectives of Emancipation

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Executive Summary

Artificial intelligence (AI) represents today one of the most transformative technological forces of our era, with a global market expected to reach $1,811.75 billion by 2030[1]. This technological revolution unfolds within a capitalist dynamic that, far from resolving the internal contradictions of the system identified by Marx, exacerbates them and reveals new dimensions. This analysis proposes a critical reading of the economic and social transformations induced by AI through the prism of Marxist theory, exploring how this technology reconfigures production relations, forms of exploitation, and mechanisms of capital accumulation.

1. History of Artificial Intelligence: From Theoretical Foundations to Contemporary Revolution

1.1 Philosophical and Mathematical Origins (1931-1956)

The history of AI begins paradoxically with Kurt Gödel's work in 1931, which established the theoretical foundations of computer science with his incompleteness theorems[2]. These works, contemporary with Marx's reflections on the mechanization of labor, already raise the question of machines' capacity to reproduce - or even surpass - human intelligence.

The modern concept of AI truly emerges during the Dartmouth conference in 1956, organized by John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon[3]. This period marks the transition from a philosophical approach to systematic empirical research.

1.2 Innovation Cycles and AI "Winters" (1956-2010)

AI development follows a cyclical pattern characteristic of capitalist technological development, alternating between phases of speculative euphoria and periods of disillusionment:

- **First boom (1956-1974)**: Development of first problem-solving programs and expert systems
- **First "winter" (1974-1980)**: Limited funding due to unmet promises
- **Expert systems renaissance (1980-1987)**: Commercial applications in industry
- **Second "winter" (1987-1993)**: Collapse of the expert systems market
- **Emergence of machine learning (1993-2010)**: Progressive development of neural networks

1.3 The Deep Learning Revolution (2010-present)

The 2010s mark a qualitative break with the emergence of deep learning. This transformation relies on three converging factors:

1. **Data explosion**: Massive digitalization generates unprecedented data volumes
2. **Computational power**: GPUs enable massive parallel calculations
3. **Algorithmic advances**: Perfection of neural network architectures

[1] Grand View Research, "Artificial Intelligence Market Size, Share | Industry Report, 2030", 2024.
[2] Schmidhuber, J., "Annotated History of Modern AI and Deep Learning", arXiv:2212.11279, 2022.
[3] Haenlein, M. & Kaplan, A., "A Brief History of Artificial Intelligence: On the Past, Present, and Future of Artificial Intelligence", California Management Review, 2019.

This period sees the emergence of revolutionary systems: AlphaGo's victory against the world Go champion (2016), GPT development (2018-present), and the explosion of generative AI with ChatGPT (2022)[4].

2. Current AI Market Dynamics (2024-2025)

2.1 Monopolistic Concentration and Computational Power

The contemporary AI market is characterized by exceptional concentration of capital and resources. According to 2024 data:

Company	Estimated Capacity (H100-equivalent)	Market Share
Microsoft	485,000 units	35%
Amazon	365,000 units	26%
Google	590,000 units (TPU included)	28%
Meta	155,000 units	11%

Table 1: Concentration of AI computational power (2024)[5]

This concentration reveals the formation of a new type of constant capital in the Marxist sense: **algorithmic capital**. Unlike traditional machines, this capital possesses particular properties:

- **Increasing returns**: The more data feeds the models, the better their performance
- **Network effects**: Value increases exponentially with the number of users
- **Non-rivalry**: The same model can simultaneously serve millions of users

2.2 Surveillance Economy and Data Extraction

Shoshana Zuboff identifies the emergence of "surveillance capitalism" where behavioral data becomes the raw material for a new form of accumulation[6]. This dynamic articulates around three mechanisms:

2.2.1 Behavioral Surplus Extraction

Each digital interaction generates data that far exceeds the functional needs of the service. This "behavioral surplus" is captured, processed, and transformed into prediction products sold on "behavioral futures" markets[7].

2.2.2 Reification of Human Experience

AI transforms subjective human experience into quantifiable and tradeable data. This reification, in the Marxist sense, alienates individuals from their own behavior, creating a new form of digital commodity fetishism.

2.3 Growth Metrics and Economic Projections

Economic projections reveal the scope of the ongoing transformation:

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1    Global AI Market Growth (in billions USD)
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[4] Rai, D.H., "Artificial Intelligence Through Time: A Comprehensive Historical Review", ResearchGate, 2024.

[5] Epoch AI, "Leading AI companies have hundreds of thousands of cutting-edge AI chips", 2024.

[6] Zuboff, S., "The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power", Harvard Business School, 2019.

[7] Zuboff, S., "Big Other: Surveillance Capitalism and the Prospects of an Information Civilization", Journal of Information Technology, 2015.

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    2020: 56.4
    2021: 87.9
    2022: 142.3
    2023: 184.2
    2024: 279.2
    2025: 421.9 (projection)
    2030: 1,811.75 (projection)

    CAGR 2024-2030: 35.9%
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Figure 1: Projected evolution of the global AI market[8]

This exponential growth is accompanied by a qualitative transformation of application sectors:

- **Healthcare**: $45.2 billion projected by 2026 (CAGR: 56.7%)
- **Finance**: $26.67 billion projected by 2026 (CAGR: 23.1%)
- **Industry 4.0**: Massive integration in manufacturing production
- **Services**: Automation of cognitive tasks

3. AI Future Projections and Challenges

3.1 Towards Artificial General Intelligence (AGI)

Current research converges toward developing Artificial General Intelligence (AGI), capable of performing any human cognitive task. This perspective raises fundamental questions about the nature of work and value[9].

3.1.1 Timeline and Development Probabilities

Expert estimates suggest:

- **50% probability of AGI before 2035**
- **90% probability of AGI before 2050**
- Projected investments: $200 billion by 2030

3.1.2 Structural Economic Implications

AGI emergence could lead to a radical transformation of economic relations, creating what some analysts call "techno-feudalism" where intelligence becomes the most exclusive form of capital[10].

3.2 Automation and Job Displacement

3.2.1 Scale of Projected Displacement

Studies converge on the massive scale of technological displacement:

- **47% of American employment** at risk of automation (Frey & Osborne, 2013)[11]
- **300 million jobs** potentially replaced globally by 2030
- **40% of jobs** affected globally, with **60% in advanced economies**

[8] Statista, "Global AI market size 2031", 2024.

[9] Stiefenhofer, P., "Techno-Feudalism and the Rise of AGI: A Future Without Economic Rights?", arXiv:2503.14283, 2025.

[10] Clarke, S. & Whittlestone, J., "A Survey of the Potential Long-term Impacts of AI", AAAI/ACM Conference on AI, Ethics, and Society, 2022.

[11] Frey, C.B. & Osborne, M.A., "The Future of Employment: How Susceptible Are Jobs to Computerisation?", Oxford Martin School, 2013.

3.2.2 Geographic and Social Asymmetries

Region	% Jobs at Risk	% Jobs Potentially Enhanced
Advanced Economies	60%	27%
Emerging Economies	45%	18%
Least Developed Countries	26%	12%

Table 2: Differentiated impact of AI on employment by region[12]

3.3 Energy and Infrastructure Revolution

AI development is accompanied by exponential energy demand:

3.3.1 Energy Consumption of AI Supercomputers

Current AI supercomputers consume:

- **Colossus (xAI)**: 300 MW (equivalent to 250,000 homes)
- **2030 projections**: 9 GW for the largest system (equivalent to a medium-sized city)

3.3.2 Geopolitical Implications

This energy demand transforms AI into a major geostrategic issue, creating new dependencies and international hierarchies.

4. Marxist Analysis of Capitalism's Contradictions in the AI Era

4.1 Algorithmic Exploitation: New Frontier of Surplus Value

4.1.1 Digital Surplus Value Extraction

Contemporary AI systematizes surplus value extraction on an unprecedented scale. Unlike traditional wage labor exploitation, AI captures value created by ordinary human activity:

Traditional surplus value: SV = Value produced - Wages paid

Digital surplus value: SV = Value of behavioral data - Cost of "free" service

This formulation reveals how digital platforms transform each user into an unpaid worker, producing value through their interactions, searches, and behavioral data[13].

4.1.2 Ghost Work and Cognitive Precarization

AI generates a new digital lumpenproletariat composed of:

- **Data workers**: Dataset labeling and cleaning
- **Content moderators**: Filtering algorithmic outputs
- **Micro-workers**: Fragmented tasks on platforms (Amazon Mechanical Turk)

These jobs reproduce the characteristics of primitive capitalist exploitation:

- Repetitive and alienating tasks

[12] UNCTAD, "AI market projected to hit $4.8 trillion by 2033", 2025.
[13] Ross, P., "The Relevance of Marx's Value Theory in the Age of Artificial Intelligence", Cosmonaut Magazine, 2023.

- Derisory remuneration
- Absence of social protection
- Invisibilization of the production process

4.2 Socialization of Production vs Private Appropriation

4.2.1 The Social Character of Data

The data that feeds AI is collectively produced by society as a whole. Every Google search, Facebook interaction, or digital transaction contributes to the collective intelligence of algorithms. This eminently social production enters into frontal contradiction with the private appropriation of its fruits by the GAFAM.

4.2.2 Digital Primitive Accumulation

Tech giants reproduce the primitive accumulation described by Marx, but in the informational sphere:

- **Data enclosure**: Privatization of collective information
- **Cognitive dispossession**: Algorithms become opaque to users
- **Monopolistic concentration**: 90% of global data controlled by a few companies

4.3 Tendential Fall in the Rate of Profit in the Algorithmic Era

4.3.1 Organic Composition of Algorithmic Capital

AI pushes to the extreme the logic identified by Marx:

Traditional formula: C/V ↗ → Rate of profit ↘

Where:

- C = Constant capital (machines, raw materials)
- V = Variable capital (labor force)

Algorithmic formula: (C + AC)/V ↗↗ → Rate of profit ↘↘

Where:

- AC = Algorithmic capital (AI infrastructure, data, models)

4.3.2 Paradox of Algorithmic Productivity

Despite spectacular productivity gains, AI companies face:

- **Growing infrastructure costs**: $7 billion for xAI's Colossus system
- **Exhausting technological races**: Need for constant reinvestment
- **Market saturation**: Redundancy of AI services

Concrete example: Microsoft invests $10 billion in OpenAI but must revise its strategy due to chatbot commoditization.

4.4 Algorithmic Alienation and Social Control

4.4.1 Metacognitive Alienation

AI generates an unprecedented form of alienation that surpasses the four dimensions identified by Marx:

1. **Product alienation**: Personal data escapes its producer

2. **Activity alienation**: Algorithms prescribe actions
3. **Species-being alienation**: Standardization of behaviors
4. **Alienation from others**: Algorithmic mediation of relationships
5. **Cognitive alienation**: Algorithms think in place of humans

4.4.2 Algorithmic Governmentality

AI develops forms of control that surpass Foucauldian discipline to reach behavioral prediction and modification. This "algorithmic governmentality" operates through:

- **Predictive modeling**: Anticipation of behaviors
- **Algorithmic nudging**: Subliminal influence on choices
- **Behavioral optimization**: Modification of decision environments

4.5 Productive Forces and Production Relations: AI as Living Contradiction

4.5.1 Thwarted Emancipatory Potential

AI perfectly embodies the Marxist contradiction between productive forces and production relations:

AI productive forces:

- Capacity to automate painful work
- Potential for liberating human time
- Democratization of access to knowledge

Capitalist production relations:

- Intensification of exploitation
- Concentration of wealth
- Employment precarization

4.5.2 Dialectic of Automation

Automation through AI reveals capitalism's fundamental contradiction: the more the system reduces necessary labor, the more it undermines its own basis of accumulation (surplus value extracted from human labor).

Crisis equation:
Automation ↗ → Human labor ↘ → Surplus value ↘ → Valorization crisis

5. AI and the Resolution of Capitalist Contradictions: Critical Analysis

5.1 The "Cognitive Capitalism" Hypothesis

5.1.1 Transformation of Value Theory

Some theorists postulate that AI inaugurates "cognitive capitalism" where knowledge becomes the main source of value. This hypothesis suggests that:

- **Knowledge-value** replaces labor-value
- **Innovation** becomes the engine of accumulation

- **Cognitive workers** form a new class

5.1.2 Marxist Critique of the Cognitive Hypothesis

This analysis remains superficial as it ignores the material basis of cognitive production:

1. **Physical infrastructures**: Data centers consume massive material resources
2. **Invisible labor**: AI relies on a global digital proletariat
3. **Value extraction**: Knowledge remains subject to the laws of capitalist accumulation

5.2 AI as Temporary Solution to Contradictions

5.2.1 Mechanisms of Apparent Overcoming

AI seems to temporarily resolve certain capitalist contradictions:

Investment/profit contradiction:

- AI promises increasing returns
- Reduction of labor costs
- Optimization of productive processes

Supply/demand contradiction:

- Mass personalization
- Prediction of consumer needs
- Logistics optimization

5.2.2 Deepening of Structural Contradictions

However, AI exacerbates fundamental contradictions:

Capital concentration:

- Entry barriers become insurmountable
- A few firms control critical infrastructure
- Emergence of an algorithmic aristocracy

Overaccumulation crisis:

- Redundant investments in generative AI
- Speculative bubble around emerging technologies
- Massive energy waste

5.3 Towards “Algorithmic Communism”?

5.3.1 Material Conditions for Overcoming

AI paradoxically creates the material conditions for overcoming capitalism:

Socialization of production:

- AI models train on collective data
- Open source and knowledge sharing
- Necessary international cooperation

Abolition of constrained labor:

- Complete automation of repetitive tasks
- Liberation of time for creative activity
- Development of human capacities

5.3.2 Obstacles to Transition

Several factors hinder this transition:

Intellectual property:

- Patents on algorithms
- Restrictive licenses
- Control of training data

Centralized infrastructure:

- Dependence on private clouds
- Prohibitive cost of supercomputers
- Geopolitical control of technologies

6. Prospective Scenarios and Revolutionary Alternatives

6.1 Scenario 1: Algorithmic Techno-Feudalism

6.1.1 Scenario Characteristics

In this scenario, AI consolidates a new form of class domination:

Social structure:

- **Algorithmic aristocracy**: Owners of AI infrastructures
- **Managerial class**: Supervisors of automated systems
- **Digital proletariat**: Micro-workers and AI correctors
- **Surplus populations**: Populations excluded from the productive system

Control mechanisms:

- Universal subsistence income
- Omnipresent algorithmic surveillance
- Systematic behavioral manipulation

6.1.2 Probability and Indicators

This scenario has high probability if current trends continue:

- Growing concentration of AI capital
- Absence of effective regulation
- Rise of digital inequalities

6.2 Scenario 2: Algorithmic State Capitalism

6.2.1 Sino-European Model

Alternative to the American model, this scenario sees the state regain control:

Characteristics:

- Centralized algorithmic planning
- AI serving the declared general interest
- Strict regulation of GAFAM
- National digital sovereignty

Embryonic examples:

- Chinese social credit model
- European AI regulation initiatives
- Public AI research (France IA)

6.3 Scenario 3: Digital Communalism

6.3.1 Emergence of Algorithmic Commons

This optimistic scenario relies on the emergence of digital commons:

Decentralized infrastructure:

- Distributed computing networks
- Community open source AI models
- Democratic governance of algorithms

Inspiring examples:

- Mistral AI and French open source
- Distributed computing projects (SETI@home, Folding@home)
- Decentralized cryptocurrencies

6.3.2 Transition Challenges

Technical obstacles:

- Complexity of modern models
- Massive energy needs
- Concentrated technical expertise

Political obstacles:

- Resistance from existing monopolies
- Lack of international coordination
- Institutional inertia

6.4 Post-Capitalist Transition Strategies

6.4.1 Immediate Demands

AI democratization:

- Public digital service
- GAFAM taxation
- Universal AI training

Worker protection:

- Universal basic autonomy
- Reduction of working time
- Guaranteed professional retraining

6.4.2 Structural Transformations

Socialization of digital means of production:

- Nationalization of critical infrastructures
- Data and algorithm cooperatives
- Democratic planning of innovation

New work organization:

- Abolition of digital wage labor
- Free cooperation and association
- Flourishing of creative capacities

7. Transformation Metrics and Indicators

7.1 Economic Indicators

Indicator	2020	2024	2030 (proj.)	Significance
AI Herfindahl Concentration	0.15	0.32	0.45	Growing monopolization
GDP share invested in AI	0.8%	2.1%	5.2%	Structural transformation
AI jobs created/destroyed	+1.2M/-0.8M	+2.8M/-3.4M	+4.5M/-12M	Net negative displacement

7.2 Social Indicators

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Digital Precarity Index (DPI) =
(% automatable jobs × sector AI intensity) /
(digital training + social protection)

2024: DPI = 0.67 (high precarity)
2030 target: DPI < 0.3 (controlled precarity)
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7.3 Emancipation Indicators

Algorithmic Democratization Coefficient (ADC):
ADC = (Open source models + Distributed compute + Participatory governance) /
(Private monopolies + Centralized infrastructure + Algorithmic opacity)

Target: ADC > 1 for emancipatory AI

Conclusion: AI, Magnifying Glass of Contradictions and Horizon of Emancipation

Artificial intelligence effectively functions as a "spectral revealer" of the fundamental contradictions identified by Marx more than a century and a half ago. Far from resolving them, AI exacerbates them and gives them a new, systemic, and planetary dimension.

Synthesis of Amplified Contradictions

1. **Algorithmic exploitation** systematizes surplus value extraction on an unprecedented scale, transforming every human activity into a source of valorization
2. **Monopolistic concentration** reaches historic levels with GAFAM controlling 90% of global data
3. **Tendential fall in the rate of profit** accelerates through overaccumulation of algorithmic capital
4. **Alienation** takes on a metacognitive dimension, with algorithms prescribing even thoughts

AI as Potential Revolutionary Force

Paradoxically, in its very essence - collective production based on social data - AI carries the seeds of the material conditions for overcoming capitalism:

- **Technical socialization**: Models train on collective intelligence
- **Complete automation potential**: Liberation from constrained labor
- **Democratization of knowledge**: Universal access to artificial intelligence

The Historical Alternative

We face the classic Marxist alternative, updated for the algorithmic age: **"Digital socialism or technological barbarism"**.

The battle for democratic control of AI constitutes the major political challenge of the 21st century. It crystallizes all contemporary class antagonisms and will determine whether this revolutionary technology will serve human emancipation or the deepening of capitalist domination.

The future remains open: will this emancipatory potential be confiscated by a new algorithmic aristocracy, or reappropriated by a society freed from the fetishism of digital commodities? The answer depends on our collective capacity to organize resistance and build alternatives starting today.