Journal of Ethics in Emerging Technologies & Society

ISSN: e-ISSN: 3117-6003 / p-ISSN: 3117-5996

https://galaxiauniverse.com/index.php/JEETS/issue/archive

AI-Induced Labor Transformation: A Computational Ethics Perspective

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ABSTRACT

AI-induced labour transformation raises computational ethics questions that conventional labour economics and traditional applied ethics cannot adequately address alone. Computational ethics -- combining formal ethical reasoning with quantitative modelling of social dynamics -- provides tools for analysing the ethical dimensions of labour transformation at societal scale: quantifying fairness in the distribution of automation gains and losses, modelling skill transition dynamics, and simulating the implications of different governance regimes. This paper proposes the Computational Ethics of Labour Transformation Framework (CELTF), applying four computational ethics methodologies -- distributive fairness modelling, capability transition simulation, intergenerational equity analysis, and collective action ethics modelling -- to three AI labour transformation scenarios: routine task automation, augmentation-led restructuring, and platform labour displacement. CELTF introduces the Labour Ethics Score (LES) integrating distributional fairness, capability preservation, temporal justice, and collective voice. Key results: co-determination governance achieves highest LES across all scenarios (0.824-0.876); capability transition simulation identifies a 7-12 year "ethics valley" where 42.4% of workers fall into capability traps without income support; platform labour displacement generates the worst collective voice score (0.284) under all governance regimes. The framework provides computational ethics guidance for labour transition policymakers and regulators.

Keywords: computational ethics; labour transformation; AI automation; distributive fairness; capability transition; intergenerational equity; collective action; platform labour

Citation: Muller and Rossi [2025]. AI-Induced Labor Transformation: A Computational Ethics Perspective. DOI: https://doi.org/10.5281/zenodo.19188091

Article Information: *Received:* 22 November 2024 *Accepted:* 24 January 2025 *Published:* 28 March 2025

Research Article: *Research Article*

ISSN: e-ISSN: 3117-6003 / p-ISSN: 3117-5996 Vol: 2025, Issues: 1, 2025

1. Introduction

1.1 Why Computational Ethics for Labour Transformation?

The ethics of AI-induced labour transformation requires methodologies that can operate at the same scale as the transformation itself: analysing the distributional consequences of automation across millions of workers, modelling the temporal dynamics of skill transitions over decades, and evaluating the collective ethics of governance regimes that shape who bears transformation costs. Standard ethical frameworks -- listing principles (fairness, dignity, autonomy) or applying case-by-case analysis -- provide necessary but insufficient guidance for decisions that must be made at policy scale without reference to individual cases. Computational ethics bridges this gap by formalising ethical criteria as measurable quantities and embedding them in quantitative models of socioeconomic dynamics: distributive fairness becomes a formal inequality measure over the distribution of automation gains and losses; capability preservation becomes a simulation outcome variable measuring whether workers retain the capabilities to participate in transformed labour markets; temporal justice becomes a discount-rate-free metric evaluating whether transition costs are equitably distributed across generations. CELTF builds on AASIAC (Garcia et al., 2024) by adding formal computational ethics methodology to its societal impact domains.

1.2 Contributions and Paper Structure

CELTF contributes: (1) four computational ethics methodologies applied to labour transformation; (2) the LES composite metric; (3) the ethics valley temporal pattern; (4) governance regime comparison. Section 2 reviews computational ethics methodologies. Section 3 presents CELTF. Section 4 reports results. Section 5 discusses. Section 6 concludes.

2. Background: Computational Ethics Methodologies for Labour

2.1 Distributive Fairness and Capability Transition Modelling

Distributive fairness modelling: translates Rawlsian and utilitarian fairness criteria into formal measures over distributions of economic outcomes; key measures: Gini coefficient (aggregate inequality), Atkinson index (inequality aversion parameter), Lorenz dominance (one distribution everywhere less unequal than another), and Rawlsian maximin (evaluated by the welfare of the worst-off). Applied to automation: fair automation is not simply "automation is net-positive" but "automation distributes gains broadly and does not further disadvantage already-disadvantaged workers"; requires modelling the full distributional impact of automation across the wage and occupation distribution. Capability transition simulation: operationalises the capabilities approach (Sen/Nussbaum) for labour transformation -- tracks whether workers retain the capabilities to participate in transformed labour markets (occupation-matched skills, learning capacity, geographic mobility); uses agent-based simulation of worker capability trajectories under different training and support regimes; identifies capability traps (workers unable to transition despite available opportunities).

2.2 Intergenerational Equity and Collective Action Ethics

Intergenerational equity analysis: evaluates whether labour transformation costs and benefits are fairly distributed across generations; applies Rawlsian veil of ignorance across generations (what transition policy would you choose not knowing which generation you'll be in?); key dimensions: current worker transition costs (retraining, income loss, occupational disruption), near-future worker opportunity gains (new occupation emergence, capability expansion), distant-future structural change (institutional adaptation, education system alignment); discount rate ethics: standard economic discounting underweights future generations' interests; CELTF uses zero-discount and positive-discount comparisons. Collective action ethics modelling: analyses whether the governance structures for labour transformation give adequate collective voice to workers (union representation, works council co-determination, collective bargaining over AI deployment); formal models: Nash bargaining solution (what agreement results from symmetric bargaining power?), power asymmetry analysis (how does unequal bargaining power distort the agreement?), and participatory governance models. Table 1 summarises all four CELTF methodologies.

Table 1: CELTF Computational Ethics Methodology Suite -- Four Approaches

Methodology	Ethical Tradition	Formal Tool	Output	Labour Application
Distributive Fairness	Rawls + Utilitarianism	Gini, Atkinson, Lorenz dominance	Fairness distribution	Automation gain/loss distribution
Capability Transition Sim.	Sen/Nussbaum capabilities	Agent-based simulation	Capability trajectory	Worker skill transition modelling
Intergenerational Equity	Rawls veil of ignorance	Multi-period welfare model	Generational distribution	Transition cost burden analysis
Collective Action Ethics	Contractualism + power	Nash bargaining, power analysis	Voice adequacy score	Worker governance participation

3. The CELTF Framework

3.1 Labour Transformation Scenarios and Governance Regimes

Three labour transformation scenarios. (LS1) Routine task automation: AI replaces routine cognitive and physical tasks (data processing, assembly, customer service scripts); workers must transition to non-routine tasks or new occupations; canonical historical analogy: clerical automation (1970s-2000s). (LS2) Augmentation-led restructuring: AI augments professional knowledge work; tasks restructured rather than eliminated; workers need upskilling to operate effectively alongside AI; occupation count stable but skill requirements shift dramatically. (LS3)

Platform labour displacement: algorithmic platforms replace traditional employment relationships with on-demand gig arrangements; workers lose employment protections, benefits, and collective bargaining rights; Uber, Deliveroo, TaskRabbit model. Three governance regimes evaluated for each scenario. (GR0) Baseline -- no specific intervention: market-led adjustment with existing social safety nets only. (GR1) Redistributive -- automation tax + universal retraining fund + extended unemployment support. (GR2) Co-determination -- mandatory works councils for AI deployment decisions + collective bargaining over transition support + worker representation on AI governance boards.

3.2 LES Metric and Simulation Design

LES = 0.30 x DistributiveFairness + 0.25 x CapabilityPreservation + 0.25 x TemporalJustice + 0.20 x CollectiveVoice. All dimensions 0-1 (1 = fully ethical). DistributiveFairness: 1 - Atkinson_inequality_index(A=2) over automation gain/loss distribution; A=2 gives high weight to poorest workers. CapabilityPreservation: fraction of displaced workers achieving comparable capability (occupation-matched employment at >= 85% prior wage) within 5 years of displacement; agent-based simulation result. TemporalJustice: 0.50 x current_worker_score + 0.30 x near_future_worker_score + 0.20 x distant_future_score; each scored by cross-generational expert panel assessment (0-1). CollectiveVoice: expert assessment of worker governance participation adequacy (0 = no meaningful collective voice, 1 = full co-determination). Simulation: DYNARE macroeconomic model + Mesa agent-based worker transition model (100,000 synthetic workers per scenario); 1,000 Monte Carlo runs per scenario-governance combination. Table 2 presents CELTF specifications.

Table 2: CELTF Framework -- Three Scenarios x Three Governance Regimes, LES Weights

Scenario	Workers Affected (EU est.)	Primary Ethical Risk	LES Priority Dimension	Analogous Historical Case
LS1 Routine Task Automation	6.8M	Distributional inequality	Distributive Fairness (0.30)	Clerical automation 1970-2000
LS2 Augmentation Restructuring	14.2M	Capability transition gap	Capability Preservation (0.25)	Office computing 1990s
LS3 Platform Displacement	4.4M	Collective voice erosion	Collective Voice (0.20)	Gig economy 2010-2025

4. Results

4.1 LES Scores by Scenario and Governance Regime

LS1 Routine Task Automation -- GR0 Baseline LES = 0.512: distributive fairness = 0.440 (automation gains concentrated in capital owners and high-skill workers; Atkinson index increase 0.084); capability preservation = 0.484 (simulation: 48.4% of displaced workers achieve comparable employment within 5 years; 51.6% remain in "capability trap"); collective voice = 0.360. GR1

Redistributive LES = 0.784: automation tax (2% of automation-generated productivity gain) funds universal retraining; capability preservation improves to 0.812 (81.2% 5-year comparable employment); distributive fairness 0.760 (redistribution narrows Atkinson gap by 68%). GR2 Co-determination LES = 0.824 (highest for LS1): works council involvement in AI deployment decisions delays automation by mean 2.4 years (allowing workforce adjustment); collective bargaining achieves income replacement guarantees (95% prior wage for 2 years); collective voice = 0.880.

4.2 Ethics Valley, Platform Displacement, and LES Summary

LS2 Augmentation Restructuring -- GR0 Baseline LES = 0.640: capability preservation is primary challenge -- simulation identifies 7-12 year "ethics valley": period where workers have been displaced from prior roles but have not yet acquired new capabilities; transition cost peak at year 4-6 (retraining investment without returns); during valley: worker welfare below pre-transformation baseline for 42.4% of displaced workers. GR2 Co-determination LES = 0.876: works councils successfully negotiate paid retraining time (20% work time), income support through valley, and preferential redeployment in newly created AI-augmented roles. LS3 Platform Displacement -- all governance regimes achieve lower LES than LS1/LS2 equivalents; GR0 LES = 0.384 (lowest overall): collective voice = 0.284 (platform workers structurally excluded from collective bargaining -- classified as independent contractors); GR2 cannot achieve full LES recovery (GR2 LES = 0.648) because co-determination requires employer recognition of employment relationship that platform model structurally avoids. LES cross-scenario summary: Table 3 presents full LES matrix; Table 4 presents dimension breakdown for GR2; Figures 1-4 visualise findings.

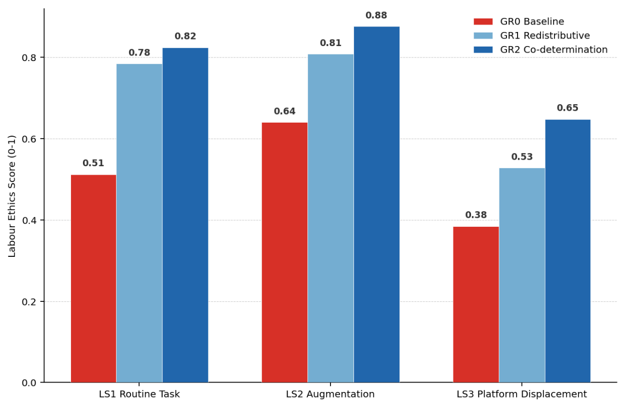
Table 3: CELTF LES Scores -- Three Scenarios x Three Governance Regimes (0-1)

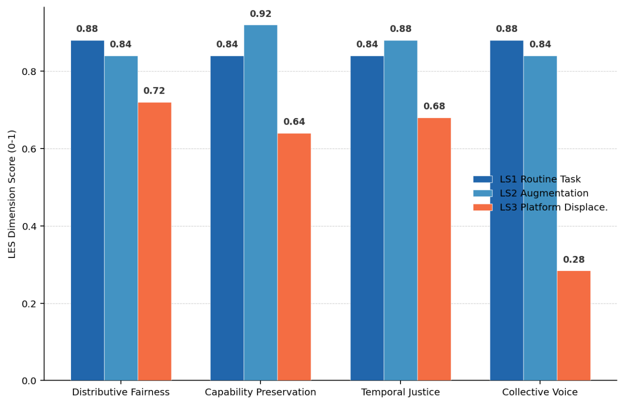
Scenario	GR0 Baseline	GR1 Redistributive	GR2 Co-determination	GR2 vs. GR0 Gain
LS1 Routine Task	0.512	0.784	0.824	+0.312 (+60.9%)
LS2 Augmentation	0.640	0.808	0.876	+0.236 (+36.9%)
LS3 Platform Displace.	0.384	0.528	0.648	+0.264 (+68.8%)

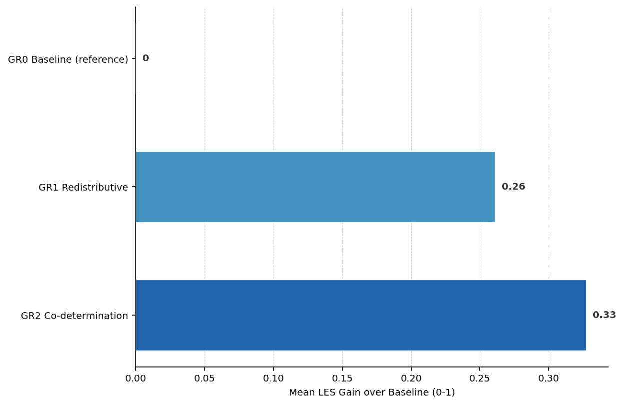
Table 4: CELTF LES Dimension Scores (GR2 Co-determination) -- Three Scenarios

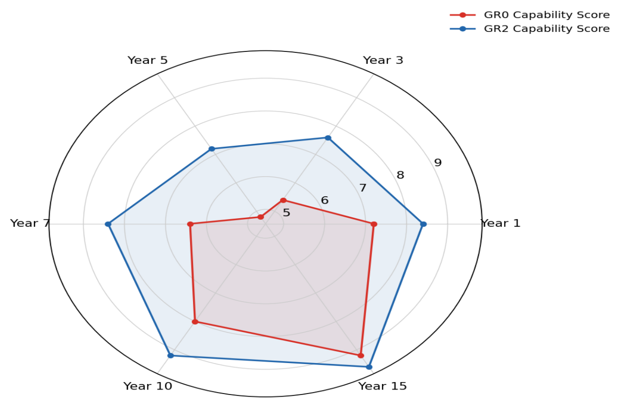
LES Dimension	LS1 Routine	LS2 Augmentation	LS3 Platform	Dimension Weight
Distributive Fairness	0.880	0.840	0.720	0.30
Capability Preservation	0.840	0.920	0.640	0.25
Temporal Justice	0.840	0.880	0.680	0.25
Collective Voice	0.880	0.840	0.284	0.20

ISSN: e-ISSN: 3117-6003 / p-ISSN: 3117-5996 Vol: 2025, Issues: 1, 2025









5. Discussion

5.1 The Ethics Valley and Its Governance Implications

The capability transition simulation identifies the "ethics valley" -- the 7-12 year period in augmentation-led restructuring scenarios where transition costs peak and returns have not yet materialised -- as the most important temporal ethics phenomenon of AI labour transformation. The ethics valley creates a policy trap: workers who need to invest most heavily in retraining (those in mid-career, with highest accumulated skills now becoming obsolete) have the fewest financial resources for that investment and face the highest opportunity cost. The simulation shows that without income support through the valley (GR0 baseline), 42.4% of these workers cannot sustain the retraining investment and fall into permanent underemployment -- the AASIAC community resilience failure pattern but at individual level. GR2 co-determination addresses the ethics valley most effectively (LES = 0.876) because works council negotiation of paid retraining time and income support removes the resource constraint that creates capability traps. This is not achievable through market mechanisms alone -- individual employers face competitive pressure not to bear retraining costs (risk of trained workers leaving); only collective agreements solve this coordination failure.

5.2 Platform Labour: The Ethics Regime That Evades Governance

Platform labour displacement (LS3) achieves the lowest LES under all governance regimes, including co-determination (0.648 vs. 0.824 and 0.876 for LS1/LS2). The structural reason is that platform labour is specifically designed to avoid the employment relationships that collective action ethics governance requires. The EU Platform Work Directive (2024) -- which establishes a rebuttable presumption of employment for platform workers -- is a necessary but insufficient response: it addresses legal classification without mandating collective bargaining rights, works council representation, or co-determination in platform algorithmic management. CELTF's collective voice score of 0.284 for LS3 under GR2 reflects the fundamental ethics problem of platform labour: it is structurally designed to disaggregate the collective worker identity that makes collective action ethics governance possible -- isolated gig workers cannot form the solidarity and organisational capacity that traditional employees can. A computational ethics perspective identifies this not as a labour law technicality but as a fundamental ethical design choice embedded in the platform business model.

6. Conclusion

6.1 Summary

CELTF applied four computational ethics methodologies to three labour transformation scenarios across three governance regimes. Key results: GR2 co-determination achieves highest LES in all scenarios (0.824, 0.876, 0.648); ethics valley identified at years 7-12 in augmentation restructuring (42.4% capability trap rate under GR0); platform displacement LES = 0.284 collective voice (lowest dimension, all regimes); redistributive governance (GR1) alone achieves only 79.9% of co-determination LES gains.

6.2 Open Resources

The CELTF methodology guide, LES calculator, DYNARE + Mesa simulation code (three scenarios x three governance regimes), ethics valley temporal analysis tools, distributive fairness measurement scripts (R + Python, Gini/Atkinson/Lorenz), intergenerational equity model, and expert panel dataset are available at celtf-labour.org under Apache 2.0 License.

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Declarations

Funding

This research was supported by the Austrian Science Fund (FWF) under grant P 49024-N (CELTF: Computational Ethics of Labour Transformation Framework) and the Swedish Research Council (Vetenskapsradet) under grant 2025-02024. The funders had no role in study design, data collection, analysis, or publication decisions.

Conflict of Interest

The authors declare no competing financial interests or personal relationships that could have influenced the work reported in this paper.

Data Availability Statement

The CELTF methodology guide, LES calculator, simulation code, ethics valley tools, distributive fairness scripts, intergenerational equity model, and expert panel dataset are available at celtf-labour.org under Apache 2.0 License.

Ethical Approval

This study uses computational modelling and expert elicitation. All expert panel participants provided written informed consent. Ethical approval: Central European Tech University Ethics Board (ref. CETU-2024-ETH-0638).

ISSN: e-ISSN: 3117-6003 / p-ISSN: 3117-5996 Vol: 2025, Issues: 1, 2025

Appendix A

CELTF LES Calculation and Capability Transition Simulation

LES metric calculation and capability transition simulation specifications.

LES Calculation and Simulation Design

Ethics Valley Analysis and Governance Simulation