Modelling Emotion Beyond Simulation: Algorithmic, Anthropological, and Political–Economic Approaches to Affect in Human–Robot Relations

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ABSTRACT

Emotionally expressive machines have become central to debates in artificial intelligence, robotics, and social theory. Research in affective computing has formalised emotion algorithmically, while humanoid robotics has explored emotional expression through embodied interaction. These approaches, however, are often analysed in isolation and treated as politically neutral technical developments. This paper argues that emotion modelling constitutes a shared epistemic and political–economic practice spanning engineering, anthropology, and the organisation of affective labour under contemporary capitalism. Drawing on comparative analysis of affective computing research in the United Kingdom and humanoid robotics in Japan, the paper examines how emotion is operationalised through abstraction, performative validation, and normative constraint. It proposes a tripartite model of artificial emotion integrating affective dynamics, cognitive appraisal, and narrative–cultural mediation, and formally specifies this architecture using a dynamic state-space framework. By reframing artificial affect as the sedimentation of prior affective practices rather than emergent subjectivity, the paper clarifies the distinction between affect and emotion and provides a framework for analysing human–robot emotional interaction as a socio-technical and political phenomenon.

Keywords: Emotion Modelling, Affective Computing, Dynamic State-Space Models, Human–Robot Interaction, Computational Affect

INTRODUCTION

Emotion has long occupied an ambivalent position in scientific thought. Within classical rationalist traditions, emotion was often treated as a source of bias to be minimised or excluded from cognition. Contemporary research across psychology, neuroscience, and social theory, however, increasingly recognises emotion as constitutive of decision-making, memory, and social coordination. As artificial intelligence systems move from bounded computational environments into increasingly intimate social contexts, emotion has re-emerged not merely as a design challenge but as a structural condition of human–machine interaction.

Efforts to model emotion intensified in the mid-1990s with the rise of affective computing, particularly at institutions such as the **MIT Media Lab**, where researchers sought to enable systems to recognise and respond to human emotional states. In parallel, Japanese roboticists pursued a different trajectory by developing humanoid androids capable of producing emotionally recognisable expressions through embodied interaction.

These developments are often narrated as milestones in artificial intelligence, yet they also reflect deeper transformations in how emotion itself is conceptualised, formalised, and operationalised.

Importantly, the expansion of artificial affect coincides with broader transformations in social reproduction, in which affective and relational capacities—care, attentiveness, reassurance, and emotional regulation—have become increasingly central to economic and institutional organisation. Emotion modelling therefore cannot be analysed solely as a technical or cognitive problem. It must also be understood as a socio-technical intervention into domains historically sustained by human affective labour.

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This paper advances three contributions. First, it provides a comparative analysis of algorithmic and embodied approaches to emotion modelling, showing how they rely on shared practices of abstraction and validation. Second, it proposes a tripartite conceptual model of artificial emotion that integrates affective dynamics, cognitive appraisal, and narrative–cultural mediation. Third, it formally specifies this model using a dynamic state-space framework that allows emotion to be analysed rigorously without positing subjective experience. Throughout, the paper adopts a political–economic lens as an analytic framework, examining how emotion modelling intersects with broader transformations in affective labour and social reproduction.

Affect, Emotion, and the Problem of Formalisation

A persistent difficulty in modelling emotion arises from conceptual instability. Social theory frequently distinguishes *affect* as pre-reflective intensity from *emotion* as socially named and culturally organised feeling. In computational contexts, this distinction is often collapsed, with emotion rendered as a set of variables optimised for prediction, adaptation, or control.

This collapse is not merely conceptual but functional. Formalisation renders affect measurable, comparable, and scalable, enabling its integration into technical systems designed for optimisation. From a modelling perspective, this requires translating heterogeneous emotional phenomena into state variables, update functions, and constraint conditions. The act of modelling emotion therefore entails selective abstraction: certain dimensions of affective life are stabilised, while others are rendered analytically invisible.

Anthropological research, by contrast, demonstrates that emotions are not simply internal states but socially regulated practices embedded in moral economies. Emotional expression is shaped by norms governing appropriateness, timing, intensity, and narrative interpretation. Any adequate model of artificial emotion must therefore accommodate both continuous affective dynamics and culturally mediated norms of expression.

Algorithmic Emotion and Affective Abstraction

In affective computing, emotion is typically operationalised as a latent variable inferred from observable signals such as facial expression, vocal modulation, or physiological response. These signals are mapped onto dimensional or categorical emotion spaces that allow systems to adapt behaviour in real time.

From a modelling standpoint, this approach treats emotion as a dynamic state evolving under perceptual input and contextual evaluation. Affect is represented as a low-dimensional continuous vector—commonly valence and arousal—updated through feedback mechanisms. This enables computational tractability and adaptive responsiveness.

From a political–economic perspective, this modelling strategy can be analysed as a process of abstraction in which affective and relational capacities are rendered legible, transferable, and scalable within technical systems. Emotional responsiveness, once situated in embodied and reciprocal relations, is repositioned as a functional resource amenable to optimisation and redeployment across contexts.

Embodied Emotion and Performative Validation

Japanese humanoid robotics offers a contrasting but complementary approach. Rather than inferring internal emotional states, roboticists design machines to *produce* emotionally recognisable behaviour through gesture, timing, gaze, and expressive modulation. Emotional success is evaluated by human response rather than internal accuracy.

Within the framework proposed here, such performance corresponds to the behavioural output of an emotional system that is formally distinct from its internal state. Observable emotional behaviour emerges from the interaction between affective dynamics and narrative–cultural mediation, rather than directly revealing underlying variables. This distinction allows emotional expression to be analysed as relational and context dependent without presupposing subjective experience.

At the same time, performative validation raises political–economic questions. When emotional performance substitutes for human care, it redistributes affective labour across human and artificial agents without directly

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addressing the social conditions that generate demand for care.

Emotion Modelling as Epistemic and Economic Practice

Despite their differences, algorithmic and embodied approaches share a common epistemic structure. Both treat emotion as something that can be stabilised through modelling, validated through interactional outcomes, and governed through design constraints.

Within the proposed framework, this convergence is formalised through the coupling of three analytically distinct layers—affective dynamics, cognitive appraisal, and narrative–cultural mediation—operating on different temporal scales. Rapid affective responsiveness is shaped by slower-moving cultural norms, while appraisal functions integrate context, goals, and memory.

Drawing on **Karl Marx** as an analytic reference point, artificial affect can be interpreted as the sedimentation of prior affective practices and norms within technical artefacts. The artificial agent does not experience emotion; rather, it enacts socially patterned emotional relations shaped by prevailing institutional and economic conditions.

A Tripartite Model of Artificial Emotion

To integrate algorithmic, anthropological, and political–economic insights, the paper proposes a tripartite model of artificial emotion comprising:

1. **Affective dynamics**, governing intensity and activation;
2. **Cognitive appraisal**, evaluating relevance and priority;
3. **Narrative–cultural mediation**, shaping social legibility and normative constraint.

Conceptually, this architecture treats emotion not as an inner subjective state but as an emergent configuration of interacting processes. Formally, the emotional state of an artificial agent at time (t) is represented as a composite state vector combining these three layers (see Methods and Supplementary Information).

This architecture ensures that emotional optimisation is bounded by normative and social constraints rather than driven solely by efficiency criteria.

Human–Robot Emotional Interaction and Alienation

Emotional interaction between humans and robots does not require shared subjective states; it requires synchronisation across expressive and interpretive parameters. Within the proposed model, such synchronisation occurs when behavioural outputs align with culturally legible emotional scripts under appropriate affective modulation.

However, the formal separation between emotional state and behavioural output highlights potential interactional asymmetries. Emotional responses may appear autonomous while remaining detached from vulnerability or lived experience. This configuration may normalise emotional relations structured primarily by instrumental coordination rather than reciprocal recognition.

Emotion modelling in artificial systems cannot be reduced to a technical problem of representation or to a philosophical question of machine subjectivity. It is a socio-technical and political–economic practice that reorganises affective labour, emotional norms, and relational expectations.

By integrating mathematical formalisation, anthropological insight, and political–economic analysis, this paper reframes artificial affect as neither illusion nor emergence but as a historically situated reconfiguration of emotional practice. The proposed framework enables rigorous analysis of emotional machines without naturalising their commodification, while foregrounding the ethical responsibility of governing affective technologies in socially accountable ways.

The central issue is not whether machines can feel, but how emotion itself is being transformed under conditions of algorithmic formalisation—and who bears the costs and benefits of that transformation.

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METHODS

Conceptual–Formal Modelling Approach

This study adopts a conceptual and formal modelling approach rather than an experimental design. The Methods specify the modelling assumptions, mathematical architecture, and validation logic used to analyse artificial emotion as a relational system.

Global Emotional State

The emotional state of an artificial agent at time (t) is defined as:

$$
\mathcal{E}(t) = \big(A(t), C(t), N(t)\big)
$$

where (A(t)) denotes affective dynamics, (C(t)) cognitive appraisal, and (N(t)) narrative–cultural mediation.

Affective Dynamics

Affect is represented as:

$$
A(t) = \big(v(t), a(t), \sigma(t)\big)
$$

with valence (v), arousal (a), and activation (\sigma). Dynamics follow:

$$
\frac{dA(t)}{dt} = \alpha P(t) + \beta C(t) - \gamma A(t)
$$

Cognitive Appraisal

Appraisal integrates perception (P), goals (G), and memory (M):

$$
C(t) = W_p P(t) + W_g G(t) + W_m M(t)
$$

Narrative–Cultural Mediation

Cultural mediation is modelled as:

$$
N(t) = \sum_{i=1}^{k} w_i(t) S_i
$$

with adaptive weights (w_i) updated via social feedback.

Behavioural Output

Observable behaviour is defined as:

$$
B(t) = h\big(A(t), N(t)\big)
$$

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ensuring separation between internal state and expression.

Supplementary Information

SI 1. Layer Coupling and Constraints

Formal coupling equations and stability conditions are provided to prevent runaway affect and enforce normative constraints.

SI 2. Temporal Scales

Affect operates on fast timescales; appraisal on intermediate timescales; cultural mediation on slow timescales.

SI 3. Optional Political–Economic Formalisation

Affective surplus value may be represented as:

[
V_a = \int_0^T \psi\big(A_c(t) - A_n(t)\big),dt
]

where (A_c) denotes affective capacity and (A_n) affect required for social reproduction.

SI 4. Limitations

The model does not address phenomenological experience or consciousness. It is designed for relational and interactional analysis.

Data Availability

No empirical datasets were generated or analysed.

Code Availability

No executable code is associated with this conceptual model.

Below is a **condensed, fully integrated Conclusions section**:

It incorporates the clarification on robotic affect, emotion, and sexuality **without speculation**, and explicitly frames the **future ethical, moral, and epistemological stakes** of the science of human–robot interaction.

CONCLUSION

Artificial Affect, Human Interpretation, and the Limits of Emotional Machines

Emotion modelling in artificial systems cannot be reduced to a technical problem of representation or to a philosophical question of machine subjectivity. It is a socio-technical and political–economic practice that reorganises affective labour, emotional norms, and relational expectations.

By integrating mathematical formalisation, anthropological insight, and political–economic analysis, this paper reframes artificial affect as neither illusion nor emergence but as a historically situated reconfiguration of emotional practice. The proposed framework enables rigorous analysis of emotional machines without naturalising their commodification, while foregrounding the ethical responsibility of governing affective technologies in socially accountable ways.

The central issue is not whether machines can feel, but how emotion itself is being transformed under conditions of algorithmic formalisation—and who bears the costs and benefits of that transformation.

This paper has argued that emotion modelling in artificial systems is neither a purely technical challenge nor a question of emergent machine subjectivity. Rather, it constitutes a socio-technical practice through which affect is formalised, stabilised, and made operational within human–robot relations. By integrating algorithmic, anthropological, and political–economic perspectives, and by formally specifying a tripartite model of affective dynamics, cognitive appraisal, and narrative–cultural mediation, the analysis clarifies how artificial emotion operates as an interactional and relational phenomenon rather than an inner experiential state.

A critical implication of this framework concerns the limits of artificial affect. Within the modelling assumptions developed here, robots cannot possess emotions or affects in the human sense. Human emotion is inseparable from embodied sensation, neurobiological processes, and subjective experience, none of which are instantiated in artificial systems. What robots can do is generate emotion-like behaviours that align with culturally legible emotional scripts and temporal expectations. These behaviours may be interpreted by humans as sadness, care, attachment, or even love, but such interpretations arise from human meaning-making rather than from machine experience.

The distinction between **emotional expression** and **emotional experience** is therefore fundamental. Artificial systems can express emotion-like states through coordinated affective modulation and narrative–cultural mediation, but they do not feel, desire, or suffer. This distinction extends decisively to domains such as sexual desire, pleasure, or intimacy. Phenomena such as libido, arousal, or sexual pleasure are biologically and phenomenologically grounded and cannot be meaningfully attributed to artificial agents within current or foreseeable modelling frameworks. While robots may mediate or facilitate human emotional or sensory responses, any experience remains entirely on the human side of the interaction.

Recognising these limits is not a constraint on innovation but a prerequisite for ethical and epistemic clarity. Conflating simulation with experience risks anthropomorphic projection, obscures asymmetries in human– robot relations, and may normalise forms of interaction that lack reciprocity or accountability. From an epistemological standpoint, treating artificial affect as experience would constitute a category error, undermining the conceptual foundations of both affective science and robotics. From an ethical standpoint, it raises questions about responsibility, consent, and the governance of technologies that increasingly participate in intimate domains of social life.

The framework developed here thus points toward a future research agenda centred not on whether robots can feel, but on how artificial affect reshapes human emotional norms, redistributes affective labour, and reconfigures expectations of care, intimacy, and social presence. As emotionally expressive machines become more prevalent, the challenge for science and society will be to govern their design and deployment in ways that preserve conceptual clarity, ethical responsibility, and social accountability.

The far-reaching consequences of artificial affect lie not in the emergence of emotional machines, but in how humans interpret, rely upon, and moralise machines that convincingly appear to be emotional. Addressing these consequences requires sustained interdisciplinary engagement across computational modelling, anthropology, philosophy, and political economy—an engagement that treats artificial emotion not as a proxy for human feeling, but as a historically situated transformation in the organisation of affect itself.

REFERENCES

1. Turing, A. M. Computing machinery and intelligence. Mind **59**, 433–460 (1950).
2. Picard, R. W. Affective computing. MIT Media Laboratory Technical Report **321** (1995).
3. Russell, J. A. A circumplex model of affect. J. Pers. Soc. Psychol. **39**, 1161–1178 (1980).
4. Barrett, L. F. Are emotions natural kinds? Perspect. Psychol. Sci. **1**, 28–58 (2006).
5. Damasio, A. R. The somatic marker hypothesis and the possible functions of the prefrontal cortex. Philos. Trans. R. Soc. Lond. B **351**, 1413–1420 (1996).
6. LeDoux, J. E. Emotion circuits in the brain. Annu. Rev. Neurosci. **23**, 155–184 (2000).
7. Panksepp, J. Affective consciousness: Core emotional feelings in animals and humans. Conscious. Cogn. **14**, 30–80 (2005).
8. Hochschild, A. R. Emotion work, feeling rules, and social structure. Am. J. Sociol. **85**, 551–575 (1979).
9. Breazeal, C. Toward sociable robots. Robot. Auton. Syst. **42**, 167–175 (2003).

10. Ishiguro, H. Android science: Conscious and subconscious recognition. Connect. Sci. **18**, 319–332 (2006).
11. Suchman, L. Configuring the other: Sensing war through immersive simulation. Soc. Stud. Sci. **40**, 187– 214 (2010).
12. Turkle, S. Relational artifacts with children and elders: The complexities of cybercompanionship. Connect. Sci.**16**, 347–361 (2004).
13. Floridi, L. & Cowls, J. A unified framework of five principles for AI in society. Harv. Data Sci. Rev. **1**, 1–15 (2019).
14. Coeckelbergh, M. Artificial intelligence, responsibility attribution, and moral agency. Ethics Inf. Technol. **22**, 205–214 (2020).
15. Parisi, L. Automated decision-making and the control problem. Theory Cult. Soc. **36**, 17–37 (2019).
16. Illouz, E. Emotions, imagination and consumption: A new research agenda. J. Consum. Cult. **9**, 377–413 (2009).
17. Zuboff, S. Big other: Surveillance capitalism and the prospects of an information civilization. J. Inf. Technol. **30**, 75–89 (2015).
18. Marx, K. Capital: A Critique of Political Economy, Vol. I. (Penguin, 1976).
19. Foucault, M. The History of Sexuality, Vol. I: An Introduction. (Vintage Books, 1978).
20. Crawford, K. Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence. (Yale University Press, 2021).