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The Co-evolution of Archaeology and Artificial Intelligence: Beyond Certainty towards Interpretive Meaning and Vagueness

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Abstract

Theoretical developments in archaeology and artificial intelligence, although unfolding in two seemingly unrelated fields, follow a shared epistemological logic. Both emerged within the context of Western modernity, initially grounded in scientism and claims to certainty, and have subsequently encountered crises of meaning, contextuality, and ethics. Adopting a comparative–analytical approach, this editorial note traces this theoretical co-evolution and demonstrates that the articles in this issue of the *Iranian Journal of Archaeological Studies* may be read as concrete manifestations of this epistemic shift, one that moves from reductive certainties toward an interpretive, multilayered, and ethically responsible form of knowledge.

Keywords:Archaeological Epistemology; Artificial Intelligence and Knowledge; Computational Certainty and Uncertainty; Crisis of Meaning; Ethics and Responsibility.

Article Type: Editorial Note

Introduction

Archaeology and artificial intelligence, at first glance, appear to belong to two entirely different domains: one oriented toward the human past and the other directed at the technological future. Yet both are products of a shared intellectual context, Western modernity and its faith in the possibility of knowledge, prediction, and control. This editorial note is grounded in the assumption that recent developments in artificial intelligence, from the binary logic derived from the Boolean algebra of George Boole, based on the reduction of propositions to nought–one values (Vardi 2014), to deep learning and generative systems (Tan and Lim 2018: 2), may be understood as a mirror of the same epistemic crisis that archaeology has experienced since the late decades of the twentieth century (Webmoor 2007; Mortazavi 2010: 149–150; 2018: 6). This comparison is not metaphorical but structural, because in both fields the central question has shifted from "how to compute" or "how to classify" toward "how meaning is produced" and "who bears responsibility for that meaning."

From the Dream of Certainty to Its Collapse

Classical archaeology, influenced by social evolutionism, viewed the human past as a linear, law-governed, and universal process (Marcus, 2008; Morgan 1877; Spencer 1863; Tylor 1870). Simultaneously, Cartesian philosophy (Cross 2012) and the rationalist tradition reduced the mind to a mechanical system that could be modelled based on formal rules (Newman 2001: 389-390). This shared assumption, the possibility of reducing human phenomena to general laws, formed the foundation of both processualism in archaeology and rule-based artificial intelligence.

The epistemic crisis of the second half of the twentieth century was not merely a technological crisis. More fundamentally, it was a crisis in the understanding of meaning. While early artificial intelligence, particularly in the form of Boolean logic and symbolic systems, pursued the comprehension of concepts, reasoning, and even the simulation of human understanding, mainstream archaeology, whether consciously or unconsciously, followed the opposite trajectory by setting meaning aside in favour of law.

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During this period, the excessive emphasis placed by archaeologists on positivism, law-oriented thinking, and formal models did not represent scientific maturity. Rather, it reflected a fear of meaning. Humans, who possessed the capacity to think, interpret, and grasp context, voluntarily reduced themselves to models designed to operate like machines. The paradox lies precisely at this point. At the very moment when machines were attempting to enter the human epistemic domain, namely the understanding of meaning, ambiguity, and context, the scholarly human withdrew from that domain.

Just as Boolean logic and symbolic artificial intelligence systems, despite their technical achievements, have been widely criticised for their limited capacity to engage with context, ambiguity, and the multilayered nature of meaning (Vardi 2014), law-based models in archaeology likewise failed when confronted with the complexity of lived human experience.

Data accumulated, yet deep understanding diminished. Explanations became increasingly precise, while interpretations grew progressively hollow. The transition to fuzzy logic in artificial intelligence, with its handling of vagueness, gradations of meaning, and non-binary reasoning (Yager 1997: 193–198), alongside the emergence of post-processual approaches in archaeology, particularly in the works of Ian Hodder (1985; 1989), constituted parallel responses to a shared crisis. This crisis lay in the recognition that truth, meaning, and human action are neither universal, nor mechanical, nor reducible to closed algorithms."

Post-processualism, contrary to the simplified assumptions of its critics, was neither a return to romantic subjectivism nor an abandonment of scientific rigour. Rather, it represented a conscious effort to restore context, interpretation, and human responsibility to the centre of knowledge production. In this sense, it marked a liberation from the very machine that was itself trapped in a crisis of meaning, a machine to which humans had retreated out of a fascination with certainty. Genuine progress is achieved neither through philosophising detached from empirical reality nor through blind engineering indifferent to meaning. It emerges only when philosophical reflection and technical formulation are critically connected rather than mutually exclusive. Wherever this connection is severed, the epistemic crisis re-emerges, whether in artificial intelligence or in archaeology.

The Articles of this Issue as Signs of Transition

The current theoretical transformation is observable in the articles of this issue, not merely as a slogan, but at the level of method, data, and interpretation. The study of microlithic tools from the Deo and Koel River Valleys on the Odisha-Jharkhand border is a clear example of moving away from grand evolutionary narratives. In this research, instead of imposing a definitive chronological framework, emphasis is placed on data distribution, local contexts, and the limitations of evidence. By acknowledging these constraints, the resulting knowledge is rendered as inherently 'provisional' and reflexive (Hodder 2000; Mickel 2015). This approach resonates with computational models that handle vagueness through graded truth values, or calibrated machine-learning systems designed to explicitly represent uncertainty and probability (Marconato *et al.* 2006).

The article concerning the ritual use of shells in the Zagros shifts this turn from the level of method to the level of meaning (Kosso 1991; Hayashi *et al.*2014). Instead of purely economic or functional explanations, shells are analysed as carriers of symbols, beliefs, and cultural continuity. This approach reflects the same critique raised in contemporary artificial intelligence regarding the reduction of meaning to mere statistical patterns (Soeffner 2020): meaning is always rooted in context and experience and is not simply computable.

In the research concerning Djeitun ceramics in eastern Mazandaran, the collapse of simple models of cultural diffusion (Johnson 1999: 18-19) is clearly visible. Neolithisation is presented not as the result of a linear path, but as the product of a network of multiple and unstable interactions (Daems 2019: 1). This networked perspective is consistent with contemporary paradigms in artificial intelligence that prioritize nonlinear representation-learning methods over traditional linear algorithms (Ullman 2019: 692).

The analysis of the painted bricks from Baba Jan re-evaluates the issue of style and power at a local level (Hill 2011). In contrast to empire-centric models, this article demonstrates that local visual traditions can maintain their own independent logic. This emphasis on locality and context aligns with contemporary critiques of globalised AI (Dauvergne 2021: 287), where seemingly universal algorithms, in practice, carry specific cultural assumptions.

The article concerning the role of the halo in Mughal court painting analyses meaning as a politico-ideological construct. In this reading, the image is a tool of power, not decoration (Saturno *et al.* 2015: 134). This perspective is reminiscent of contemporary concerns regarding the generation of narratives by generative systems (Chandrasekaran and Goel 1988: 422-423): who creates meaning, and what power structure does this meaning serve?

Finally, the article "Scientific and Ethical Considerations in Sampling..." is the point of convergence for all these discussions. This research moves ethics from the periphery of methodology to its centre and raises a question that both archaeology and contemporary artificial intelligence are inevitably forced to confront: what are the limits of knowing? Just as in AI today, where the question "Should we?" has increasingly come to overshadow "Can we?" (Meske *et al.* 2020: 56–57), in archaeology as well, scientific and social responsibility have become an inseparable part of knowledge production (Mortazavi 2010; 2018).

Within the phenomenological horizon, the care for indigenous culture does not signify the preservation of the past, but rather the continuity of meaningful experience in the present (Struthers and Peden-McAlpine 2005). Modern technologies and artificial intelligence can be tools, yet only when they do not displace the life-world, reduce experience to data, or eliminate human responsibility. If indigenous culture is severed from experience, it exists but is not alive. The philosophical rethinking of knowledge means returning to the truth that knowledge, before being a calculation, is the occurrence of meaning within human experience. Artificial intelligence does not negate this truth; rather, by exaggerating the logic of representation, it reveals it. If this warning is not taken seriously, AI will become not only a tool for knowledge but a false substitute for understanding. However, if there is an opportunity for phenomenological rethinking, knowledge can be reconnected to experience, responsibility, and meaning. The philosophical rethinking of knowledge is a process in which an epistemic system reveals its ontological, epistemological, and value assumptions, accepts the limits of its knowledge's validity, and places the ethical and social responsibility of knowledge production and application at its centre (Olsson 2011).

On a deeper level, what is observed across these six articles, in a scattered yet coherent manner, is a return to one of the most fundamental epistemological disputes in the history of thought: the distinction between "knowing" and "seeing". As historical accounts of the meeting between Avicenna and Abu Sa'id Abul-Khayr demonstrate (Mojtabaei 1996: 5–22), analytical reason and acquired knowledge (knowledge by acquisition), as well as presence-based and experience-oriented knowledge (knowledge by presence), each recognise the limitations of their own path in the absence of the other.This gap clearly illustrates a danger that contemporary artificial intelligence also faces: the substitution of "human understanding" with "computational knowledge". The articles in this issue, by emphasizing the vagueness inherent in interpretive contexts and the uncertainty of probabilistic data, alongside local meanings, unstable interaction networks, and the ethics of sampling, serve as a reminder. They suggest that if knowledge is severed from experience, context, and social responsibility, it slides into a false certainty, failing to distinguish between graded truth and statistical probability.

From Theory to Governance: Smart Cultural Heritage as a Testing Ground for Meaning

The scientific meeting "Smart Cultural Heritage: Perspectives on Artificial Intelligence and Digital Transformation in Sistan and Baluchestan Province" was held on 16 December 2025, on the occasion of Research Week, at the auditorium of the Technology Units Incubation Centre of the University of Sistan and Baluchestan. This meeting was organised through the initiative of the Department of Archaeology at the Faculty of Literature and Humanities and the Archaeological Sciences Research Centre, in collaboration with the Faculty of Mathematics, Statistics, and Computer Science and the Faculty of Electrical and Computer Engineering of the University of Sistan and Baluchestan, and with the participation of the General Directorate of Cultural Heritage, Tourism, and Handicrafts of Sistan and Baluchestan Province (Figure. 1).

The concluding statement of the scientific meeting "Smart Cultural Heritage: Perspectives on Artificial Intelligence and Digital Transformation in Sistan and Baluchestan Province" can be regarded as an objective and institutional extension of the same epistemic transition outlined theoretically in

Figure. 1: *The scientific meeting "Smart Cultural Heritage: Perspectives on Artificial Intelligence and Digital Transformation in Sistan and Baluchestan Province" was held on 16 December 2025).*
(After: Archive of the Cultural Heritage, Tourism and Handicrafts Organization of Sistan and Baluchestan Province).

this editorial note. If the current text speaks of the collapse of certainty and the shift of focus from calculation to meaning, this meeting demonstrates that this transformation is not merely an abstract or academic concern, but has reached the levels of policy-making, heritage management, and cultural governance.

The participants' emphasis on the vulnerability of sites, data fragmentation, the weakness of digital infrastructure, and the absence of an integrated decision-making system are precisely the symptoms introduced in this note as the consequences of a simplistic, tool-oriented approach to knowledge. Within this framework, the issue is not merely "digitalisation" or "smartification" as the addition of technology, but rather a rethinking of the logic of knowing and acting: how data acquire meaning, who is responsible for their interpretation, and what kind of cultural understanding technological decisions serve.

The proposal to establish a think tank for the governance of cultural capacities and modern technologies, the founding of a Centre for Artificial Intelligence and Digital Heritage, and the emphasis on sustainable institutional collaboration, all demonstrate that the transition from traditional management to smart governance is impossible without linking interpretive knowledge, ethics, and technology. This is exactly the point highlighted in the comparison between contemporary archaeology and artificial intelligence: technology gains meaning only when it is situated within a network of responsibility, context, and human experience, rather than replacing them.

From this perspective, the meeting's statement can be seen as an institutional reading of the same epistemological warning raised in this note. "Immediate smartification of sites and data", "standardisation and integration of information", and "localising global experiences", if understood as purely technical projects, risk reproducing the same false certainty that this text has critiqued. However, if, as emphasised in the meeting's final conclusion, a conscious union of knowledge, technology, and governance is intended, then smart cultural heritage can become a testing ground for living with interpretive vagueness, probabilistic uncertainty, and social responsibility.

In this sense, the report of this meeting is not an external addition to the editorial note, but rather empirical evidence that the crisis of meaning and the necessity of philosophically rethinking knowl-

edge are occurring simultaneously at theoretical, field, and policy-making levels. Smart cultural heritage, if properly understood, is not the end of human interpretation, but the beginning of a stage where technology is increasingly called upon to recognise its limits and place itself at the service of meaningful human experience.

Conclusion

Juxtaposing these six articles demonstrates that contemporary archaeology, much like calibrated systems of artificial intelligence, has moved away from the dream of absolute certainty. It has entered a stage where interpretive vagueness, probabilistic uncertainty, meaning, power, and ethics occupy the centre of attention. This issue of *IJAS* can be regarded not merely as a collection of case studies, but as an invitation to epistemological rethinking: an acceptance of complexity, sensitivity to context, and a commitment to responsibility. The future of this discipline, like the future of smart technologies, will be shaped not by a return to simplistic certainties, but by its capacity to navigate the nuances of graded truth and to respond to the consequences of knowing.

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