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FROM DUNHUANG TO THE SHAN HAI JING: ALGORITHMIC CULTURE FACILITATES CONTEMPORARY TRANSLATION OF CULTURAL HERITAGE AND THE RECONSTRUCTION OF ART DESIGN EDUCATION

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Abstract: This study proposes a dual-algorithm approach for integrating artificial intelligence into art and design education, combining a genetic algorithm and a cultural algorithm. We applied these methods in two pedagogical interventions focused on Dunhuang Murals and the Classic of Mountains and Seas (Shan Hai Jing). Using recursive generation and generative adversarial network (GAN) training, the genetic-algorithm pipeline preserved approximately 92% of traditional cultural symbols as measured by a symbol-matching metric. The cultural algorithm—designed to simulate sociocultural selection and incorporate iterative user-feedback—achieved an 88% symbol-matching rate and demonstrated positive cross-cultural reception in IP adaptation trials. These results suggest that algorithmic systems can function not only as technical tools but also as vectors for rematerializing cultural memory and accelerating cultural evolution. In light of these findings, contemporary art and design education should move beyond teaching tool use toward cultivating "digital humanists"—practitioners who can design, tune, and critically evaluate cultural algorithms.
Keywords: Genetic algorithm; Cultural algorithm; Dunhuang murals; Shan Hai Jing (Classic of Mountains and Seas); Art and design education; Cultural memory

1 INTRODUCTION

From the 1990s, algorithms that were seen as backend tools turned into core mechanisms to produce culture and disperse meaning. The advent of generative artificial intelligence technologies is transforming art and design fields in unprecedented ways. While the image generation and story generation technologies seem incredibly powerful, they also pose serious issues. The Western culture infused in Artificial Intelligence may tend to misrepresent non-Western culture systematically. Recent studies have reported high error rates, for instance, general AI tools misrepresent traditional Chinese visual features, reporting pattern errors ranging from 63% to 87%, particularly with regard to the Dunhuang murals, Shan Hai Jing, and the Miao batik. The reconstruction error rate of general AI for the above-mentioned visual elements is much higher than that of classical Western and modernist content. If measures are not implemented, this tech bias risks exacerbating a further erosion of cultural representation of Chinese heritage.

And today the art and design education paradigm cannot function with emulation-style apprenticeship anymore. This requires students to undergo such a large transformation, learning algorithm logic and cultural depth simultaneously, which can not only make Millennia-old patterns parameterization, but also fight against data hegemony at an ethical level.

The findings of its two longitudinal teaching experiments in our institution’s digital AI workshop from 2023 to 2025 are:

“Contemporary Interpretation Project of Dunhuang Caisson Patterns” contributed to an innovative genetic algorithm method capable of preserving 92% of traditional cultural symbols through recursive generation, adversarial training, and mineral pigments’ spectral mapping.

"The Global Recoding of Shanhaijing Mythological IP" developed a cultural algorithm which imitated the mechanisms of sociocultural evolution, achieved an 88% symbol match and cross-cultural acceptance. The system enabled up-to-date iteration using user heat maps and analysis over 30 international areas.

This research demonstrates that algorithmic systems are “programmable civilizations” rather than “destroyers” that can learn and form through education. In the critical approach, it aims at moving towards elevating algorithmics from technical means, and toward a cultural medium that encapsulates shared memory, incorporate normative ethics, and promotes cultural cultivation. So the point of contemporary art education and design is not simply to train students to work with AI, but to enable them to tune and critically assess the cultural algorithm. This will make the students not passive recipients of the age of the algorithm, but creative designers of culturally sensitive algorithms.

Three groups of key tensions can be countered by this research temp.

Between 92% precision and the 12% of an incalculable 'flash of insight'.

Between a global acceptance of 88% and indigenous cultural subjectivity.

Algorithmic automation and humanistic critique.

In the following two sections we analyze the principles, pedagogical strategies and educational impacts of genetic algorithms and cultural algorithms.

2 GENETIC ALGORITHM: INTEGRATION OF CULTURAL MATHEMATICS AND COMPUTING TECHNOLOGY IN ART AND DESIGN EDUCATION

The genetic algorithm that blends cultural mathematics with modern computer technologies offers a new perspective for contemporary art and design education. It facilitates tradition's cultural core with the new technology. Concurrently, this serves as both a precisely parameterized technical device and a powerful mechanism for remediating cultural memory in the digital realm. The recursive algorithm converts "three hares" patterns to symbols amenable to calculative and recursively expandable operations, breaking apart Buddhist reincarnation, cosmic cycles, and temporality. In other words, it translates the "stream of consciousness of inner time" of Husserl into the logic of the algorithm, keeping alive and reproducing ancient religious-aesthetic experiences in modern code[1-2].

2.1 Teaching Reconstruction under the Phenomenological Lens

In the present study, selected Dunhuang caisson ceiling patterns have been translated using a combination of algorithm and Colored patterns: three hares, flame pattern, lotus position and honeysuckle design patterns. The Samsara, Mandala-style symmetrical aesthetics, the golden ratio, and the spectral gradient of mineral pigments were accurately depicted by the recursive algorithm. Furthermore, 92% of the cultural symbols were retained following iterative optimization and GAN training[3]. Drawing on Merleau-Ponty's concept of the "body schema", this approach extends embodied perception to digital interfaces, whereby touching screens, motion capture, gesture recognition, and even VR equipment, students can control Genetic Algorithms and, via this change, create cross-temporal perceptual resonance with the Dunhuang artisans of a millennium ago, in response to subtle changes such as finger swipes, gestures in the air and body postures. As a result, this multi-modal experience visual, tactile, kinesthetic, and spatial perception integrates the body and technology, ancient and contemporary, of matter and digital code[4].

In hermeneutic circle this pattern translation process is precisely a dynamic practice of Gadamer's "fusion of horizons" (Gadamer, 1960/2004). The students in this context come to understand ancient craftsmen's cosmology, views on reincarnation, and visions of liberation as they face the limitations due to the cave environment in dim lighting, mineral pigment, and religious ritual. Subsequently, they transform this tacit knowledge into computable recursive functions, parametric curves, generation and color mapping rules, employing contemporary algorithmic reasoning. This dialogue is bidirectional, facilitating connections across everything, all times, cultures, and paradigms. The process suggests that tradition represents a dynamic body of knowledge that can be reactivated, reinterpreted and revitalized today.

From the perspective of the ontology of education, the genetic algorithm classroom is an experimental field and a growth space in the cultural psychology theory of Jerome Bruner. It's no longer just a teaching-only classroom where they teach some technical skills. The emphasis of today's teaching, however, lies in nurturing the cultural-psychological profile of the students. By being involved in Dunhuang pattern translation projects, students master advanced technologies like recursive generation, parametric modelling, generative adversarial training and color spectral mapping. This involvement fosters an ongoing conversation with norms that are over a thousand years old, often involving trial and error and empathetic engagement. This produces peculiar cultural psychological patterns, aesthetic judgment, and identities, which in turn moves cultural transmission from external indoctrination into internal generation[5].

2.2 Educational Enlightenment from Cultural Topology

The 92% symbol retention rate shows the genetic algorithm's educational value using Deleuze and Guattari's (1987 A Thousand Plateaus) topological perspective[6]. Algorithmic delocalization frees patterns from their material carriers—cave murals and fabrics—allowing them to flow freely and recombine iteratively in smooth space. Parametric modeling reconstitutes striated space on top of smooth space, transforming line directions, color hierarchies, symmetry relationships, and scale rules into precisely controllable, real-time adjustable, and cross-media migratable design parameters. Based on student-led variation and lines of flight experiments facilitated by algorithms, they generate artworks that are not carriers of meaning; they retain deep structures of cultural symbols while breaking away from traditional aesthetic frameworks, facilitating the development of experimental spirit, critical thinking, and creative imagination.

From the perspective of Jan Assmann's theory of cultural memory, the pedagogical process establishes a three-level chain[7]. The storage memory activates learners' historical cognition of religious metaphor and zeitgeist through a repository of cultural symbols (such as the Dunhuang pattern semiology and mineral pigment spectrum). This enables the generation of rules in dynamic grammars that can be programmed with a recursive algorithm (such as the parametric cloud pattern generator and the recursive function for the hui-pattern). communication memory facilitates the reconstruction of contemporary cultural and spatial effects through human-machine collaborative (such as the AR pattern co-creation platform and the cloud-based collaborative design space) interface.

In this way, from the perspective of Paulo Freire's critical pedagogy[8], these three progressive stages develop critical cultural awareness: In the Conscientization stage students analyze the constitutive principles and historical context of the Pantone color system thereby uncovering the underlying Western aesthetic hegemony and cultural centralism. The practical stage manifests tensions between local mineral pigments and Western industrial color systems, applied according to the stringent $\Delta E \leq 3$ standards, represents a technical negotiation of cultural sovereignty in parameter tuning[9]. In the dialogic stage, it visually presents the acceptance and emotional responses to the same artwork in a

cross-cultural environment through heat maps. In this they will learn to reach minimal agreement amid differences, enabling students to negotiate while preserving co-creation. According to this triple pathway, Assmann's theory is utilized as a longitude and Freire's pedagogy as latitude in cognition, technology, and ethics. This supports students to transition from being passive recipients to active producers of meaning. It supports the values of "truth, goodness, and beauty" in the context of algorithmic abundance, revitalizing millennia-old patterns in the digital world.

Benjamin's concept of the "aura" in the Age of Mechanical Reproduction" could benefit from a genetic-algorithm upgrade, which suggests a partial restoration of the aura with 92% symbol retention[10]. Meanwhile, Adorno's critique of the culture industry calls for vigilance and critical thought to prevent culture from becoming a ruling object or a homogeneous commodity under the logic of the algorithm[11]. Building on this, Pierre Nora's theory of "lieux de mémoire" positions digital education platforms with algorithmic library systems that position Dunhuang manuscripts as repositories of enduring archival memory. Through pattern translation projects, immersive exhibitions, co-creation workshops, and more, the classrooms reconstruct the memory of rituals of cultural heritage. Students' design work utilizes algorithmic variation and transforms them into counter-memories and cultural antibodies against global sameness and algorithmic hegemony[12].

3 CULTURAL ALGORITHM: INTELLIGENT OPTIMIZATION SIMULATING HUMAN SOCIETY'S CULTURAL EVOLUTION IN ART AND DESIGN

In fields like art and design education, the use of cultural algorithms injects unparalleled life, strength, and impetus to respond to the cultural change in human society. A teaching project involving the IP translation of the Classic of Mountains and Seas led Generative Adversarial Networks (GANs) to construct contemporary public art objects, interactive media, and urban layouts following Classic myths like "Jingwei Filling the Sea," "Kuafu Chasing the Sun," and "Gonggong Butting the Mountain" successfully. They had also achieved an 88% performance in cultural symbol matching rate, narrative fit, and cross-cultural acceptance. The genius of cultural algorithms to come up with ideas, carry out culture transmission and global communication.

3.1 Cognitive Philosophy Critique on Cultural Evolution

The Shanhaijing Project brings to light philosophical contradictions and tensions in multiple cognition in the cultural evolution of the algorithm era. The heat map, offering real-time cross-cultural feedback, is a perfect tool for transforming aesthetic assumptions, as well as subjective beliefs, into data-falsifiable, iteratively updatable objects. This suggests that cultural translation can transform from elite speculation and subjective interpretation into a data-informed, continuously evolving object of empirical research. Merging the Post-traditional aesthetic paradigm and visual styles from the West, the 88% symbol matching rate develops a novel visual grammar and narrative logic that fosters global dialogue and cross-cultural resonance[13]. Cultural algorithms are stripped away by the mechanism of 'natural selection' and reorganized by communication efficiency, emotional arousal, and commercial value parameters. Through the seemingly objective algorithmic "logic", a new power of knowledge reconstruction emerges — quietly dispelling, resetting, and reproducing the interpretive power of traditional myths and their cultural subjectivity[14].

3.2 Educational Construction of Ethical Topology

Levinas's own "philosophy of the Other" stresses the responsibility to the Other is infinite: it must be taken personally. It re-affirms the calls for presence in being in a confrontation with the Other. It rises above the self toward the Other in terms of needs. This transformation of the digital cultural heritage has been a four-dimensional matrix of responsibility[15]:

(1) The respect for tradition is fulfilled by a set of cultural taboos, which are like a historical firewall, protecting against the desecration of certain symbols.

(2) A contemporary response is embodied through a real-time verification system, akin to an 'ethical probe', in order to establish an 'ethical pause' which sharpens students' judgment in unique situations.

(3) The future responsibility emerges from an entropy detector, which measures the cultural diversity and complexity of the work, which helps students move away from their short term perspectives and take responsibility towards the broader goal of what they would contribute to the long term gene pool of civilization.

(4) Respect for the Other is manifested by a cross-civilizational heat map breaking the illusion of 'universal aesthetics'. It invites students to use concrete, diverse, and irreducible cultural "visages". Furthermore, learning to understand the rationality of the Other's logic within difference.

This matrix is what the student uses to see and take responsibility for those other than themselves and is therefore the door to the realization of the conditions for dialogical translation through technology and dialogue, regarding the civilized way, and for sustainable evolution.

Hegel's thesis-antithesis-synthesis dialectic gives a straightforward teaching structure[16]: within 72 hours, GANs can generate hundreds of visual prototypes and interactive scenes from the symbols of "Shan Hai Jing", effectively breaking time, skill, and imagination barriers of traditional design[17]. The CLIP multimodal model has a semantic departure of 0.15. It sometimes gives rise to blind spots in the algorithms due to a lack of understanding of the deeper cultures, or being blind to taboos or context sensitivity. Left unchecked, it may result in blasphemous use of symbols, creating

stereotypes, and cultural appropriation, and so on. It occurs through the students' critical revision, facilitated over many rounds of cultural decoding-ethical reflection-meaning reconstruction-form adjustment, with the result that expressions with a cultural basis, contemporary in nature, can be formulated with a capacity to engage in conversations around global issues occurring in the context of technology-related crises.

Intercultural competence, as the Core Competences in Digital-age, formed through a framework of three levels. In the cognitive layer, the course "Critiques of Said's Orientalism" allowed students to study and analyze the identification and deconstruction of algorithmic outputs based on geographic, gender, and power biases[18]. According to theory of communicative action, the ethical dimension attending responsibility attribution, empathetic understanding, and negotiated consensus building in heat map difference networks[19]. Finally, informed by dialogic theory, the creative layer must be prepared to develop the 'translation interface,' wherein mythological fragments are reorganized for different users. These interfaces help create 'third spaces' to respond to different cultural manifestations.

To protect 12% cultural heterogeneity, Adorno's negative dialectics draws on the philosophy of non-identity. It is a necessary tool, since 88% is matching. Therefore, it follows that minimal morality and maximal respect form key moral education practices of the cultural algorithm[20]. It delivers $\Delta E \leq 3$ standards. John Durham Peters's elemental media theory allows for a four-dimensional experience of new design subjects– Earth (the digital compiling of rooted cultural genes, e.g., Miao batik parametric modeling), fire (the creative destruction by GANs, e.g., humanistic intervention of Xingtian images), air (meaning perception in global fluctuations through heat maps, e.g., Dunhuang Feitian hierarchical optimization), and finally water (the adaptive shaping of carry-cross-border collaborations, e.g., silk road hybrid patterns). So students can become new humanists who protect humanistic constellations in algorithmic jungles and tame technology with humanistic reason[21].

4 CONCLUSION: CIVILIZATIONAL NERVE ENDINGS IN THE ALGORITHMIC ERA

Art and design education is increasingly the place where human culture stays alive and keeps making sense in an algorithmic world. Indeed, genes and culture now rely on algorithms to pass down, store, and evolve collective memory. As a result, cultural ideas now evolve faster through real-time feedback and global collaboration, thereby pushing art and design education to focus less on preserving skills and more on training creators who can code, design, troubleshoot, and think critically about culture's algorithms. Algorithms have finally managed to turn the kind of hands-on know-how that craftsmen never write down into something that can actually be measured, shared, and reused across different fields through neural networks. All this is now possible with motion capture, eye-tracking, muscle sensors, neural networks, and various related technologies. In the end, it establishes a real, working bridge for passing craft knowledge across cultures, generations, and media.

The aims of art and design education are dedicated to cultivating digital humanists who have the ability to master advanced algorithmic technologies while upholding the depth and diversity of culture. A global heat map reveals that the world is in a state of dynamic interconnection, and human society has reached high interconnectivity, particularly in the digital age. Thousands of years of painting and calligraphy still resonate when we encode them into computer code. That's precisely what digital humanists do, mixing code with traditional signs and symbols, bringing old practices back to life on screen, and allowing today's workers to design new work to keep it diverse and impossible to condense to a single meaning, all of it distributed through algorithms. Indeed, that is precisely what contemporary art and design education must do today — and may very well determine whether human civilization can survive, evolve, and start over in the digital age.

COMPETING INTERESTS

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