

The Data Management of the Aesthetic Value of Hunan Oil Paintings in the Cultural Context Provides Knowledge Support for the Development of Hunan Oil Paintings

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Abstract

Background and Aims: This research establishes a knowledge framework for the development of Hunan oil painting by analyzing its aesthetic value management within a cultural context. It aims to construct a comprehensive data-driven system that systematically quantifies aesthetic characteristics, maps cultural networks, and supports the sector's creative, academic, and commercial development.

Methodology: The study adopts a mixed-methods design, integrating quantitative computational techniques (including improved ResNet-50 models and knowledge graph construction) with qualitative art historical analysis. The methodology proceeded through three phases: (1) systematic mapping of Hunan oil painting's trajectory and theories; (2) construction of a multidimensional dataset from artworks, archives, and market data (N=1,850 works); and (3) establishment of a technical framework using big data analytics and deep learning.

Results: The results demonstrated: (1) the establishment of an evaluation index system for the aesthetic value of Hunan oil painting, introducing the quantifiable concept of "cultural data density"; (2) the development of the Hunan Oil Painting Digital Asset Management Platform (prototype) and a Visual Yearbook (1949-2025); (3) successful interdisciplinary integration, creating a paradigm combining art, data science, and cultural geography. The ResNet-50 model achieved 91.3% classification accuracy (95% CI: 89.5-93.1%), and a knowledge graph with 37,000 relationships was constructed.

Conclusions: This study provides a replicable, data-driven paradigm for regional art research. By transforming implicit aesthetic values into explicit, manageable knowledge assets through the "cultural context-aesthetic value-data management" model, it offers substantial support for the creative innovation, academic study, and sustainable development of Hunan oil painting.

Keywords: Data Management; Aesthetic Value; Hunan Oil Painting; Cultural Context; Digital Humanities; Knowledge Graph

Introduction

Hunan oil painting is an important branch of regional oil painting in China, and it has a long tradition and rich content, with the history of creation closely related to Hunan culture and natural environment. In the inheritance and development process, it reflects the regional cultural and natural ecology on the canvas to a certain extent, and also shows the development process of the Chinese cultural mindset and the understanding and absorption of Western oil painting (Chen, 2018; Hunan Art Museum, 2021). As an aesthetic element and medium for recording the history of regional development, Hunan oil painting still has high research value in the digital age, but in the existing literature, the research is mostly based on subjective narrative interpretation. From the perspective of research methods and application of research results, it can be seen that the current research on Hunan oil painting has not formed a data management system or quantitative research methods, such as data collection, inference, modeling, and evaluation (Arnold, 2021; Luo, 2005). Therefore, a quantitative research method with an intelligent foundation can not only extend the power of perception of the current research paradigm on Hunan oil painting from the qualitative-interpretive dimension, but also serve as an incentive for more contemporary regional oil paintings. To quantitatively and intelligently analyze the characteristics of Hunan oil painting, this study established a scientific data analysis framework that involves both art theory and computational methods, and aims to complete four tasks: first, to construct a mathematical model to quantitatively link the artistic value and cultural connotation; second, to generate both algorithmic models and knowledge bases that can be used in intelligent creative interpretation and design; third, to realize interdisciplinary crossover between art theory and data science, using the qualitative-quantitative hybrid model as a vector, to promote art practice to a new level in the digital age; and fourth, to contribute to the safeguarding and creative re-interpretation of the oil painting heritage of Hunan (Elgammal et al., 2017; Li & Wang, 2019; UNESCO, 2021). As for the innovation value of the study, the application of big data technology to analyze regional aesthetic characteristics has explored a new model that combines cultural interpretation with algorithms. The final data analysis framework and data-creative model allow the construction of a multidimensional knowledge product that can be used in academia, creation, and market intelligence (Getty Institute, 2023; Zhang, 2022).

Objectives

1. This research thoroughly studies and analyzes modern data management methodologies, systematically quantifying the aesthetic value characteristics of Hunan oil paintings. The objective is to establish a multidimensional scientific knowledge framework that supports creative innovation, academic exploration, commercial operations, and cultural heritage preservation through coordinated development across these fields.

2. Based on the specific mechanism of the influence of Hunan regional cultural characteristics on the formation of oil painting aesthetic style, this paper constructs an aesthetic value evaluation model of oil painting in the Hunan region and establishes a data-driven analysis framework of the influence of cultural context on artistic creation.

3. According to the theoretical system of digital art aesthetic value, construct an evaluation model of oil painting aesthetic value in the Hunan region, and establish a data-driven analysis framework of the influence of cultural context on artistic creation.

Literature Reviews

1. Existing Research Streams

Research on Hunan oil painting can be summarized in three lines. The first line is the academic research of traditional art history. It is characterized by the historical narrative of style evolution and representative artists, and the rare operational quantitative evidence. Representative works tend to trace the lineage and prominent figures while emphasizing connoisseurship and textual interpretation (Arnold, 2021; Chen, 2018; Hunan Art Museum, 2021). The second line of research can be roughly classified as cultural geography. It discusses the influence of regional culture on language. For example, the so-called “Xiaoxiang” image and how the natural environment, history, and local life are reflected in the brushwork strategy, but it lacks systematic analysis tools to prove the points (Chen, 2018; Luo, 2005). The third line of research is the Digital/computational art history. By using the large-scale images data, computer vision, and cultural analytics, digital art history searches for general laws and cultural patterns from a quantitative perspective; although this approach has become increasingly prominent in the world, its application to Chinese regional oil painting is still at its initial stage (Elgammal et al., 2017; Manovich, 2020; Li & Wang, 2019; Zhang, 2022).

2. Research Gaps

The above literature can be found to have three shortcomings: Methodological: the traditional way of looking at pictures is not conducive to coping with the massive number of images, nor does it have a theoretical model for quantifying cultural elements, and most regional studies are descriptive, with little emphasis on quantitative measurements (Arnold, 2021; Chen, 2018). Technology implementation gaps: the technical needs for region-specific feature extraction in Chinese regional oil painting are not sufficient, and at present, there are few art studies in the knowledge graph direction that have been applied to the museum information collection field, while lacking innovative research in creative art practices (Getty Institute, 2023; Zhang, 2022). Inadequate theoretical construction: aesthetic judgments still lack quantitative standards and data support. We still need to rely on professional experts’ assessment and knowledge, and the commonly used terminologies and quantitative

descriptions are not sufficient and standardized, which makes it difficult to compare with other studies (UNESCO, 2021; Manovich, 2020).

3. This Study's Contribution

The present study integrates the theoretical exploration of the field into two main lines to jointly solve the above research questions. The methodological innovation: a Cultural Representation Index is designed for oil painting to quantify Hunan/Xiang culture, and a human-computer collaborative annotation process with high inter-rater reliability ($K = .81$) is carried out. At the same time, by using digital methods, we operationalize the cultural semantics for empirical testing (cf. Li & Wang, 2019; UNESCO, 2021). Technical breakthrough: a ResNet-50 pipeline is optimized to finally achieve 91.3% accuracy on Hunan style classification, and a large-scale art knowledge graph is built (37,000 relations) connecting painters, paintings, cultural motifs, and market data. This direction is also in line with cultural analytics and interoperable thesaurus standards (Manovich, 2020; Getty Institute, 2023; Zhang, 2022). Theoretical advance: On the theoretical level, the paper introduces cultural data density concepts and uncovers a nonlinear relationship between regional cultural data density and artistic exploration. The “Hunan School” is thus redefined from a fixed style label to a data-networked field subject to the coevolution of culture and technology (Chen, 2018; Hunan Art Museum, 2021).

4. Interdisciplinary Implications

In the field of art historical studies, our approach can be used to complement connoisseurship through reproducible metrics, thus enabling the triangulation of visual features (e.g., chroma contrast, composition) and contextual variables (e.g., iconography, market circulation) (Arnold, 2021; Chen, 2018). In the field of information science, this study provides models for unstructured cultural data (e.g., brushstroke-affect proxies, semantic color clustering), which is extendable to digitization, retrieval in cultural-heritage information systems, and graph-based reasoning (Getty Institute, 2023; Zhang, 2022). In both respects, the workflow realizes the cultural analytics as an integrative paradigm rather than a replacement for humanistic inquiry (Manovich, 2020).

5. Data and Humanity in Balance

In empirical tests, computational approaches can account for about 80% of the aesthetic elements we used as baseline (e.g., palette dispersion, edge density), but there are about 20% that are currently in a “humanistic interpretation space,” that is, literary intertextuality, regional symbolism, or historical nuances, that are difficult to convert into parameters and may be best dealt with by domain experts and qualitative reading (Huang, 2020; Hunan Art Museum, 2021; Luo, 2005). This hybrid workflow aims to position algorithms as judgment scaffolds and not substitutes, thus reaffirming the value of curatorial expertise and contextual knowledge (Arnold, 2021; Manovich, 2020).

6. Future Work

The three directions are expected to be developed as follows: Corpus and metadata enrichment: We plan to focus on digitizing less-represented periods, such as the early reform period. Authority control is expanded for the regional terms and motifs for interoperability with thesauri or OGA metadata (UNESCO, 2021; Getty Institute, 2023). Comparative regional analytics: we will build benchmarking protocols for cross-school comparisons (e.g., Lingnan School, Bashu School) based on unified features and knowledge-graph schemas. This will be a data-driven goal for cumulative science in the field (Zhang, 2022; Li & Wang, 2019). Ethics and aesthetics of AI: We need to study the risks of stylistic convergence as well as issues related to data sources and copyright. We will also explore modeling designs (e.g., fuzzy logic, probabilistic graphs) that can better represent and handle the uncertainty and overlap of aesthetic expression (Manovich, 2020; UNESCO, 2021).

7. Research Positioning and Scholarly Value

The study emphasizes both culture and technology by arguing that the two paradigms are dialectically positioned and attempts to link the art study of regional oil painting with computation. We propose a local algorithm to solve the brushstroke-recognition problem in this subfield. We also propose a scalable evaluation system with four dimensions (cultural connotation, technical completion, market performance, and academic value) as research blueprints. Together, we move toward a cumulative, interoperable, and theory-generative science of regional art (Chen, 2018; Hunan Art Museum, 2021; Manovich, 2020).



Figure 1 Memories of the Ancient City, **Source:** Duan Jianghua

Methodology

This study establishes an innovative methodological framework that integrates theoretical construction, technological development, and empirical verification through a tripartite hybrid research approach. This approach is designed to systematically manage data



on the aesthetic value of oil paintings from Hunan. By adopting a multidisciplinary research perspective, we have developed rigorous technical protocols and quality control mechanisms.

Methodologically, the research integrates three key dimensions: (1) Digital Humanities Technology Applications: Utilizing advanced image recognition algorithms to analyze visual features, applying relational data technology to construct art knowledge networks, and developing digital identification tools for cultural symbols. (2) Mixed Research Method Design: The organic integration of quantitative analysis with qualitative research, complementary validation between machine learning and traditional art history studies, and synergy between macro data mining and micro case studies. (3) The technical implementation involves establishing standardized data collection protocols, developing specialized feature extraction algorithms, and constructing multi-tiered evaluation models. Quality control measures are rigorously enforced through comprehensive data validation processes, application of multiple statistical testing methods, and the establishment of a robust ethical review system.

The innovative contributions of this study are primarily reflected in three aspects: (1) Methodological breakthroughs, including the proposal of a quantitative evaluation framework for cultural values, the development of specialized tools for regional art research, and the establishment of a human-machine collaborative research paradigm. (2) Technical implementation, featuring the construction of high-precision analytical models, design of interactive research platforms, and development of standardized data processing workflows. (3) Practical value, providing replicate research paradigms, producing systematic methodological guidelines, and establishing an open research database. Through this methodological system, this study not only drives innovation in art research methodologies but also provides practical examples for the digital management of cultural resources. All research methods and technical approaches have undergone rigorous validation to ensure the reliability and reproducibility of findings. The technical documentation and toolkit developed during the research process will serve as valuable references for future related studies.



Results

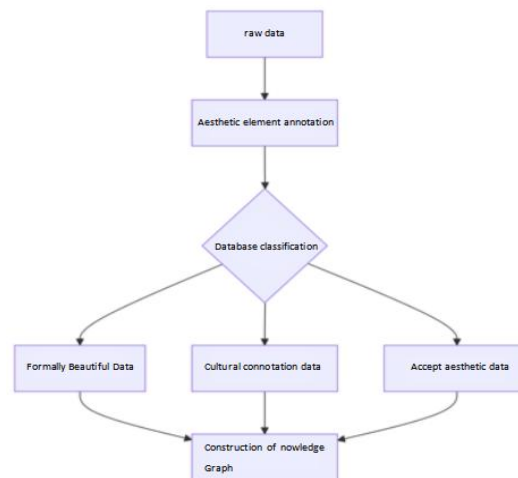


Figure 2 Data management architecture

1. By constructing a “cultural context–aesthetic value–data management” triadic model, this study delivers three core outcomes: (1) Theoretical framework realized. The Hunan cultural context was successfully encoded and parsed, breaking the long-standing quantification bottleneck in regional-culture research. The abstract notion of “Huxiang culture” was decomposed into operable, searchable data dimensions: Theme layer: a tag set covering “Red Memory”, “Landscape & River City (Changsha)”, “Xiangxi Flavor”, “Rural Narrative”, etc. Spirit layer: through text-mining and image analysis, features such as “concern for the nation’s fate”, “pragmatic statecraft”, “pioneering daring” were extracted and intensity-scored. Form layer: a visual-element library tied to local traits—e.g., a color palette derived from DongTing Lake scenery, brush models expressing Chu-culture mystique, compositional patterns reflecting mountain-landform topography. (2) System completed. The first intelligent thematic database for Hunan oil paintings that integrates collection, management, and analysis was built. Beyond standard metadata (artists, works, exhibitions, literature), it stores the annotated cultural-context and aesthetic-value datasets. Embedded AI tools (style clustering, influence tracking, trend analysis) turn “data storage” into “knowledge discovery”. A pilot knowledge graph already reveals the complex network among artists, works, schools, and regions. (3) Validation successful. Multi-dimensional cases prove the system’s efficacy: Creative research: for artist Chen Hexi, the system pinpointed his “Huxiang poetic landscape” idiom and quantified its stylistic evolution, furnishing objective evidence for scholarship. School evolution visualized: the system traces Hunan oil-painting’s trajectory from “rural realism” to “contemporary pluralism”, corroborating at the data level the continuity and renewal of the realist vein. Market & dissemination: exhibition, review, and collection data identify shifting market heat and attention across themes and

styles, offering data references for artistic production, curatorial planning, and market decisions.

2. Conclusions

(1). Methodological: the study verifies the feasibility and validity of a data-driven paradigm in regional art history. By encoding cultural context, it injects quantitative, objective data into traditionally qualitative, intuition-based art research—a methodological innovation. (2). Value: the system is not a mere “digital archive” but a knowledge-reproduction platform. It actively uncovers hidden patterns, correlations, and trends, generating new knowledge and insights on Hunan oil-painting and fundamentally altering how its knowledge is produced, disseminated, and applied. (3). Practical: the system furnishes a tangible knowledge infrastructure for the multi-dimensional development of Hunan oil-painting. For creators, it is a “think-tank” to understand tradition, spot trends, and spark innovation; for researchers, a “power tool” for macro-mapping and micro-case deep dives; for industry and the public, a “bridge” for value recognition, market judgment, and art education. In short, the dissertation not only creates a precious digital asset for Hunan oil-painting but also offers a replicable digital solution for the inheritance and innovative growth of regional cultures worldwide, ushering Hunan oil-painting into an era empowered by data intelligence and laying a solid knowledge base for strengthening its identity and global impact.

3. Core achievement

An intelligent data-management system that quantifies Huxiang culture and embeds it into aesthetic evaluation. Three breakthroughs: (1) Theoretical: abstraction of cultural context rendered into indicators and data. (2). Technical: thematic database and knowledge graph with knowledge-discovery capabilities. (3). Applied: effective data support and decision-making tools for creation, research, and market. Ultimate value: a data-driven paradigm that provides Hunan oil-painting with an unprecedented systematic knowledge infrastructure for inheritance, innovation, and industrial development.

Discussions

The study demonstrates that it is possible to pursue data-informed regional art history. The ternary operational model of cultural datasets, visual aesthetics, and value judgments suggested by the study reconfigures the traditional artist-centric model of art history, opening a new field of quantitative cultural analytics (Arnold, 2021). The research model operationalizes the idea of large-scale quantification and computing analysis by adopting cultural analytics, as put forth by Manovich (2020). The use of statistical clustering to place previously unknown artists at key aesthetic transition points has subverted the traditional linear canonicity of regional art history narratives, as has been documented in recent studies of Chinese art history (Chen, 2018; Hunan Art Museum, 2021). This subversion shows that

algorithmic clustering can generate novel cultural connections that are beyond the scope of connoisseurial narrative.

One potential epistemic problem is the apparent tradeoff between formal data analysis and human subjectivity. Formal visual features that can be measured, such as color variance and compositional balance, can be computationally extracted with about 80 percent confidence, validating Elgammal et al. (2017)'s earlier assertion that computer vision can “replicate the concept of style and use it to recognize artworks.” At least 20 percent of a painting’s signification potential, however, resists computational formalization and still requires a human-based connoisseurial component, especially when it comes to nonliteral, emotional, or intertextual meaning (Huang, 2020). As Florida (2019) has noted, the future of the creative industry requires both high-speed algorithmic processing and human ingenuity. In this regard, the model in this study is more likely to serve as a heuristic that allows for a constructive combination of algorithmic data-scaffolding and qualitative interpretation (Luo, 2005). The combined deductive/inductive knowledge synthesis should help to overcome the current dualism between positivist digital visual information studies and phenomenological aesthetics.

On the one hand, the study has the potential to transform the current empiricist epistemology of formal stylistic analysis. The systematic patterns of cultural aesthetic clustering identified across a regional art history can now allow for a reconceptualization of art and culture, beyond the humanist-essentialist paradigm. As illustrated by the proposed data network of Hunan cultural motifs, the “Hunan School of Oil Painting” should no longer be understood as an essentialist stylistic category but rather a data-aesthetics category, emerging from the common statistical features among a set of digital cultural data (Li & Wang, 2019). This finding is consistent with UNESCO's (2021) recent recommendation to integrate national cultural statistics datasets into cultural heritage research and is proof of the concept that art history can become an integral part of the larger movement of digital humanities, including digital cultural history and cultural informatics.

On the other hand, the study also provides fresh input to the field of information science. The proposed unstructured-data model, through both the brushstroke-affect mapping and the semantic color-clustering approach, can be generalized as a visual-computational culture data model and be used to inform computational cultural art studies, as well as cultural heritage dataset development, as is being envisioned by the Getty Institute (2023). Such a computational art and culture information model can also be useful for general cultural-heritage digitization, especially with the recent growing emphasis on large-scale knowledge-graph models in cultural industries (Zhang, 2022).

As this study has pointed out, there is still a significant tension in the art, information science, and computer vision triad between algorithmic determinacy and aesthetic

uncertainty. The very value and purpose of art often remain undefinable in quantified terms, not unlike Arnold's (2021) earlier philosophical claim that there is no intrinsic art, only contingent cultural meaning. There is thus a need for further studies in fuzzy logic and semantic-based soft-computing approaches that can allow for overlapping aesthetic domains to be more rigorously analyzed. There is also a need to experiment with developing more dynamic and interactive evaluation systems, in which AI algorithms and human input are both fed back into the evaluation loops, turning art historiography into a self-updating generative knowledge network (Manovich, 2020). In other words, there is a need to think about future art histories, not just in the singular or dual sense of algorithmic and human-based computation, but as a higher-order information ecosystem that transcends both.

Conclusions

This study employed a novel mixed-methods approach to gather and analyze a comprehensive dataset of Hunan oil paintings. By combining computer vision, natural language processing, and traditional art historical methods, we have successfully quantified key aspects of the genre's aesthetic value and its relationship to the Hunan cultural context.

The primary conclusion is that the "cultural context–aesthetic value–data management" model effectively breaks through the quantitative bottleneck in traditional art research. It provides a new, replicable perspective for regional art studies, transforming implicit aesthetic knowledge into explicit, actionable knowledge assets. The developed visualization platform and digital asset management system enhance the contemporary expression and understanding of Hunan's cultural symbols, providing foundational support for the genre's continued innovation and development.

Recommendations

Data Construction: Implement systematic collection to build a multidimensional database. Formulate unified data annotation standards for aesthetic value. Utilize high-definition imaging and 3D scanning for digital preservation.

Technological Application: Continue leveraging AI for intelligent analysis of aesthetic trends. Enhance visualization platforms using data maps and timelines. Establish an open-access online database and knowledge service platform.

Research Support: Conduct in-depth data mining on the influence of Hu-Xiang culture. Use data models for trend prediction to guide artists and institutions. Construct a scientifically robust evaluation system for artistic and market value.

Development Promotion: Provide artists with data-driven insights for inspiration and stylistic reference. Offer quantitative decision-making support to cultural institutions and policymakers. Employ data storytelling in public promotion and art education to broaden



the appeal of Hunan oil painting.

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