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THE CULTURAL CODE OF THE CITY IN THE AGE OF ARTIFICIAL INTELLIGENCE

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Abstract. The article explores the role of artificial intelligence (AI) as a mediator in the interpretation and preservation of Riga's Art Nouveau architecture. It examines how digital technologies such as computer vision, generative design, and immersive media (VR/AR) contribute to recognizing, systematizing, and reimagining the city's architectural and cultural identity. The study emphasizes that AI is not only a technical instrument but also a cultural agent capable of translating visual and symbolic aspects of urban heritage into a new digital language. Special attention is given to the ethical dimensions of using AI in the context of authenticity, authorship, and the balance between heritage preservation and creative reinterpretation.

Key words: artificial intelligence; cultural heritage; Art Nouveau; digital humanities; generative design; computer vision; immersive technologies; digital reconstruction.

Introduction. In recent decades, the rapid advancement of digital technologies has transformed how cultural heritage is preserved, analyzed, and interpreted. Artificial intelligence (AI) has gradually moved beyond traditional engineering tasks to become a significant tool in the humanities, the arts, and architecture. One emergent line of inquiry is the use of AI to study the cultural code of cities – that is, the constellation of visual, symbolic, and historical elements that shape their unique identities.

Riga occupies a special place in European cultural heritage due to the richness of its architectural environment [1, 2]. The city's cultural code is most vividly expressed through Art Nouveau (Jugendstil), which is represented in more than a third of the buildings in the historic center. Decorative facades, sculpted mascarons, vegetal ornaments, and symbolic compositions form a complex visual language in which early-twentieth-century artistic tendencies intertwine with national motifs. However, this language is not always readily accessible to contemporary audiences, especially in a digital age in which engagement with the urban environment is increasingly mediated by technology.

AI opens new possibilities for dialogue between a city's cultural code and digital art. Computational methods make it possible to identify and systematize characteristic features of Art Nouveau, while generative models enable artistic interpretations that bring to light latent regularities of the style. Augmented and virtual reality, powered by AI, transform the perception of urban space by turning architecture into an interactive experience. In this sense, AI acts as a mediator between past and present, between heritage and innovation.

The aim of this article is to explore how AI can facilitate the detection, analysis, and re-interpretation of Riga's cultural code through digital practices. The focus is on Art Nouveau architecture as a central component of the city's visual identity. To this end, the article examines:

- the features of Riga's cultural code and its manifestation in Art Nouveau;
- contemporary AI methods for analyzing architectural forms and ornaments;
- digital design and artistic practices grounded in Riga's Art Nouveau;
- the role of AI as a mediator of cultural experience.

Taken together, the article seeks to show not only how AI can aid in the preservation and dissemination of architectural heritage, but also how it can open new artistic horizons for its interpretation.

The Cultural Code of Riga: Art Nouveau Architecture as the Language of the City

Riga's architectural heritage is not only a crucial part of Latvia's national identity but also one of the key components of its cultural code. Architecture functions not merely as a functional envelope of urban space but also as a medium for expressing societal values, identity, and historical memory. In Riga, this symbolic role is particularly pronounced: the city's rich Art Nouveau (Jugendstil) heritage reflects the social and cultural processes of the early twentieth century, a period marked by both economic and cultural flourishing. Each facade and decorative element constitutes part of a visual language through which the city's cultural code is transmitted – a system of symbols, styles, and motifs that shape its unique identity. Among the various architectural styles present in the city, Art Nouveau occupies a special place, and it is thanks to this style that Riga has gained international recognition as one of the largest centers of Art Nouveau in Europe. More than one-third of the buildings in the historic city center (approximately 800) are designed in this style, creating a unique visual environment (Krastiņš, 1988).

Art Nouveau in Riga can be conditionally divided into several strands:

- Decorative Art Nouveau: richly adorned facades with abundant sculptural details, mythological and symbolic figures;
- National Romanticism: a fusion of Art Nouveau with Latvian ethnocultural motifs, ornaments, and natural symbols;
- Functional Art Nouveau: more restrained forms emphasizing utilitarianism and rhythmic organization of facades.

These buildings carry multilayered symbolic meanings. Ornaments, mythological figures, and geometric patterns act as a kind of "subtext," which can be interpreted as a manifestation of the city's cultural code. For instance, natural motifs (vegetal and floral ornaments) symbolize the city's connection with the living environment; mythological figures (mascarons, winged creatures, atlantes, sphinxes, etc.) reflect the search for harmony between material and spiritual realms; and geometric forms and rhythmic lines underscore the modernist pursuit of order and balance.

The visual richness of Art Nouveau provides fertile ground for analysis using **artificial intelligence** methods. Computer vision and pattern recognition algorithms allow for the identification of recurring elements (e.g., ornaments or mascarons) and the detection of compositional regularities. Moreover, modern generative models are capable of "reconstructing" Art Nouveau architectural motifs, producing new artistic interpretations that do not undermine the cultural code but rather reveal its latent potential. Together, these elements form a symbolic layer of architecture, transforming buildings into "texts" that can be interpreted as expressions of Riga's cultural code.

In this way, Art Nouveau can be regarded not only as an architectural phenomenon but also as an algorithmically readable one, where the interaction of humans, urban space, and technology opens new horizons for digital design and artistic exploration.

Artificial Intelligence in the Analysis and Interpretation of Architecture

Contemporary methods of artificial intelligence offer new opportunities for the study and representation of architectural heritage. In the context of Riga's Art Nouveau, this is particularly significant, as the style is characterized by high decorative richness and a multiplicity of symbols and ornaments, making it an ideal material for algorithmic analysis.

Computer Vision and the Recognition of Architectural Elements. One of the most promising applications of AI in architectural analysis is so-called **computer vision**. This technology employs deep learning and neural networks to recognize objects, people, patterns, and more. Convolutional neural networks (CNNs) – a specific type of neural network designed to work with spatially structured data such as images and video, enable the automatic identification and classification of individual façade elements, including mascarons, sculptural figures, and vegetal ornaments. These technologies make it possible not only to recognize individual elements but also to systematize

them in digital databases, contributing to the creation of comprehensive collections of Riga's architectural motives.

Machine learning algorithms allow for the detection of stable visual patterns characteristic of different Art Nouveau strands, from highly decorative facades to more restrained functional designs. This approach not only structures the architectural heritage but also deepens understanding of the artistic principles underlying Riga's cultural code.

Generative Models. Generative models, such as Generative Adversarial Networks (GANs) and diffusion models, open new possibilities for the artistic interpretation of Art Nouveau architecture. By training on digital images of buildings (provided a sufficiently rich dataset), these algorithms creating new variations of facades that preserve the distinctive features of the style while presenting them in original combinations. This approach enables the visualization of potential reconstructions of lost architectural details and the creation of digital artworks inspired by Riga's architecture. Generative design allows for the recreation of missing facade elements, such as sculptural ornaments or mascarons, that have deteriorated over time. Importantly, the algorithm does not copy existing examples literally but combines motifs based on identified patterns. This makes it suitable not only for restoration purposes but also for use in digital art and interactive exhibitions. As a result, generative models become tools not only for preservation but also for the reinterpretation of architectural heritage: they "revive" Art Nouveau, revealing its cultural code through new artistic forms.

Analysis of Patterns and Hidden Connections. Beyond recognizing individual elements and generating new images, AI can reveal hidden regularities in Art Nouveau architectural forms. By comparing thousands of façade images, algorithms can identify recurring motifs (mascarons, vegetal ornaments, mythological figures) and determine their frequency, variation, and local characteristics. This approach allows architecture to be understood not merely as a collection of individual buildings but as a system governed by specific artistic principles. AI-based visual analytics enables the comparison of buildings across different areas of Riga and the identification of artistic "clusters" – zones where particular ornamental motifs or substyles of Art Nouveau predominate. This opens the path toward creating a kind of "Art Nouveau genome," documenting key stylistic regularities. In this way, AI serves as a research tool that reveals deep connections between architectural forms and the city's cultural code, making this code accessible for analysis and interpretation in a digital environment.

New Forms of Representation through Art and Digital Design. AI is not limited to the analysis and reconstruction of architectural forms; it is also actively employed in the creation of new artistic practices based on Art Nouveau heritage. Generative algorithms can transform façade motifs into digital art objects, which are used in interactive exhibitions, media art projects, and visual installations. These artworks do not replicate historical architecture but offer a contemporary interpretation within the modern cultural context. Examples of such applications can be seen, for instance, in the Riga Art Nouveau Museum. A key direction is the use of augmented and virtual reality technologies, where AI overlays digital layers onto real buildings. Visitors can see facades as they appeared a century ago. This approach not only revitalizes architectural heritage but also turns engagement with it into a personal and emotionally immersive experience. These AI-driven digital practices create new ways of representing Art Nouveau, expanding the perception of architecture and opening a dialogue between history and contemporary art. Overall, AI becomes a mediator between historical architecture and modern artistic expression, providing tools for both scholarly analysis and creative reinterpretation of the Art Nouveau style.

Digital Practices and Art Based on Riga's Architecture

Generative Design. Contemporary generative design methods, based on machine learning algorithms, allow the creation of artistic interpretations of Riga's architecture while preserving its stylistic features. Ornaments, mascarons, and decorative façade elements become "visual seeds" from which AI generates new images. These images are not literal copies of buildings but represent original

combinations of elements inspired by the aesthetics of Art Nouveau. Such practices find applications in graphic design, media art, and even architectural experiments from developing virtual facades to creating interior objects stylized according to Art Nouveau motifs. As a result, they form not only an aesthetic experiment but also a way to revitalize architectural heritage, integrating it into the contemporary visual language.

Virtual and Augmented Reality for Cultural Heritage. Virtual reality (VR) and augmented reality (AR) open new avenues for representing Riga's Art Nouveau architecture. Augmented reality (AR) allows viewers to see the original appearance of buildings, for example, by visualizing lost decorative elements on facades or restoring ornaments that have been damaged over time. AR applications enable the overlay of digital layers onto real buildings, visualizing their historical appearance or presenting artistic variations created based on the analysis of facade motifs. Virtual reality (VR), in turn, offers the opportunity to immerse oneself in the urban environment of the early 20th century, experiencing the spatial and aesthetic context as it might have been more than a century ago, and allows users to navigate a virtual "Riga gallery" where architectural objects become part of an artistic narrative. These solutions not only promote educational and aesthetic engagement but also strengthen the connection between residents and the city's cultural identity. VR and AR help viewers perceive architecture not as a static object but as a dynamic cultural narrative unfolding through digital technologies. Thus, digital technologies expand the boundaries of the museum experience: architecture ceases to be a fixed object, transforming into a dynamic and accessible form of art (Bailenson et al., 2023).

Examples of Projects Implemented in Latvia. In Latvia, such initiatives are still developing selectively, but several notable examples can already be highlighted. Digital art exhibitions in Riga have incorporated Art Nouveau architectural motifs into multimedia projections. Heritage preservation projects have also employed laser-based 3D scanning technologies to create the foundation for subsequent VR reconstructions. Some key projects include:

- **Virtual Art Nouveau Museum**. The project "Riga Art Nouveau Centre: Digitisation of Cultural Heritage and Development of a Virtual Museum" (EEA Grants) ran from 2013–2016 and resulted in a digital database of approximately 1,000 items (photos and descriptions in LV/EN/DE) and a virtual museum exhibition, available since September 30, 2016. The project aimed to ensure broad accessibility and professional presentation of Riga's Art Nouveau heritage. It continued under international EEA Grants, including knowledge exchange with Norway, enhancing the quality of virtual exhibitions. Within Latvia's national cultural policy, the creation of a digital Art Nouveau database was planned, including documentation of 1,000 items, photography of 700 objects, digital copying of 300 objects, and development of exhibition materials, all ensuring preservation and accessibility (EEA Grants, Riga City Council, n.d.).
- **AR Photo Album "Pastaiga pa skaisto Rīgu".** A significant example of integrating cultural heritage and digital technologies in Latvia. The project was implemented in collaboration with the Latvian National Archives and the Museum of the History of Riga and Navigation. The publication is an illustrated album containing over 200 historical photographs, most digitally restored. A key innovation is the use of augmented reality technology. Through the mobile application Old Riga, readers can compare historical images with current views of 75 city locations and explore twenty archival video materials. The AR photo album combines historical photography with augmented reality technologies, creating an interactive experience of Riga's cultural heritage (see Fig.1, 2).This combination of traditional print with interactive digital content provides a multilayered perception of Riga's cultural and historical space, serving as a model practice in the digitalization of cultural heritage (SIA Pastaigas, 2024). In 2025, virtual books with similar content were also released about Jūrmala and Jelgava, allowing users to take a virtual walk through these cities using a dedicated smartphone application.



Figure 1. The AR photo album *Pastaiga pa skaisto Rīgu*

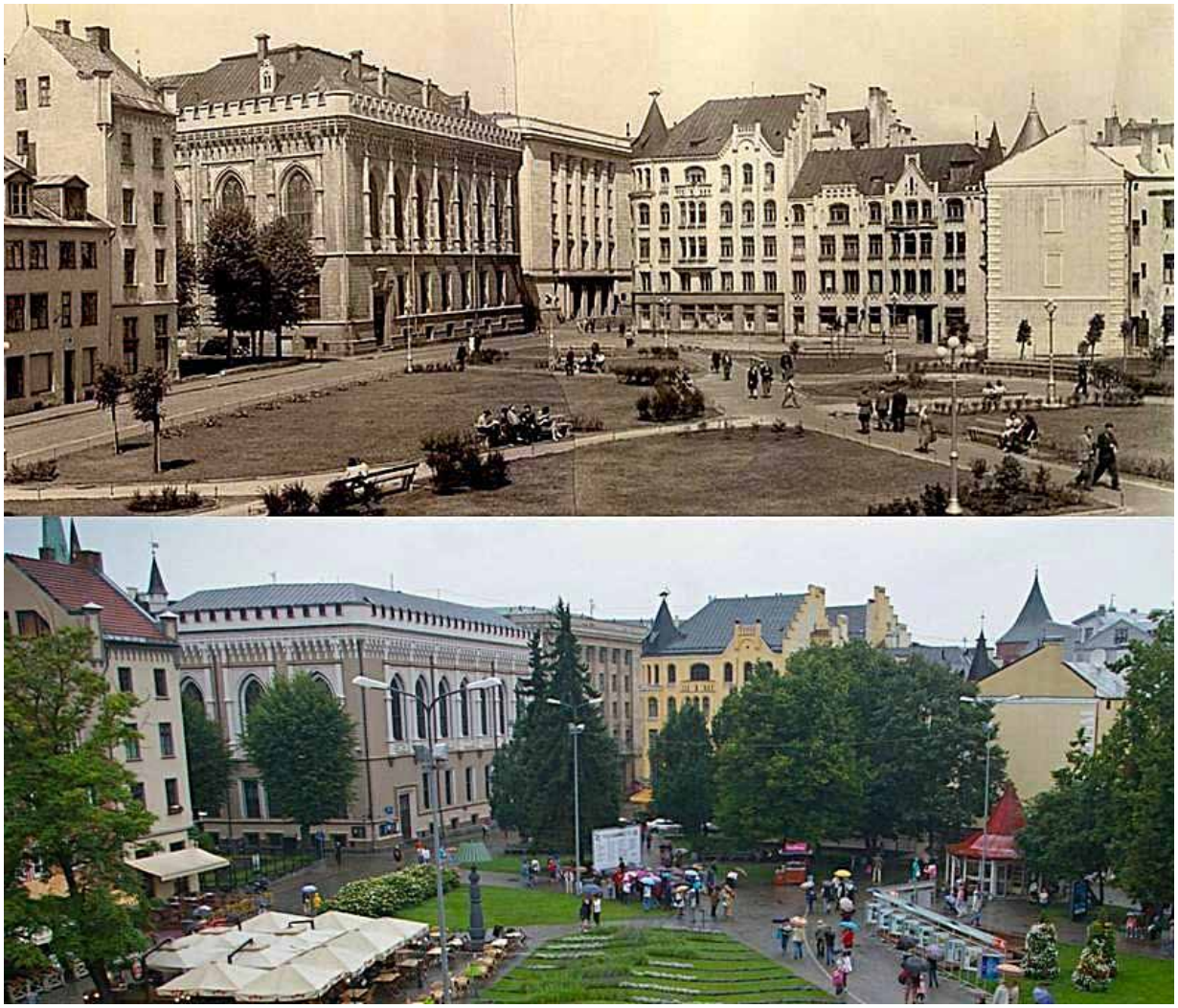


Figure 2. Historical and contemporary views of Riga from the AR photo album *Pastaiga pa skaisto Rīgu*

- **Riga NouveauLens.** Launched in July 2025 by Spectra Labs in collaboration with the Riga Art Nouveau Centre, this mobile application overlays historical visualizations, animations, symbolic information, color reconstructions, and archival quotes from architects onto building facades via AR. Supported languages include Latvian, English, and German. Features include a "Symbolism Explorer" (explaining symbols), a "Time-Lapse" comparison with the building's state in 1905, text annotations from archives, and geolocation of lesser-known architectural gems, a prime example of how technology revitalizes Art Nouveau in public spaces (Baltic Review, n.d.).
- **Riga's Art Nouveau Quest Experience.** A mobile quest application launched in August 2025, allowing users to explore the city's Art Nouveau landmarks through tasks, puzzles, and augmented content. Participants learn the history of buildings via an interactive gamified format (Eventbrite, n.d.).
- **RIXC Art and Science Festival 2025.** The festival featured the program "Resonances of Nature," combining AR installations and immersive practices, intersecting art, nature, and technology. Latvian and international media artists created interactive projects using AR/VR. The festival demonstrates how digital art can resonate with Riga's Art Nouveau visual aesthetics. Plant motifs and organic Art Nouveau forms are interpreted through VR, AR, and generative design, producing interactive "animated" images. Just as Art Nouveau facades form the city's cultural code through patterns and symbolism, digital installations visualize natural forms while maintaining attention to detail and engaging viewers emotionally in a contemporary media context (Eventbrite, n.d.).

AI as a Mediator of Cultural Experience

Artificial intelligence is increasingly used as a tool that allows contemporary audiences to interpret cultural heritage. Computer vision algorithms and data analysis identify ornamental patterns, symbols, and compositional features of Art Nouveau architecture. As a result, buildings are perceived not only as physical objects but also as "texts" encoding the values and aesthetics of the past. For the viewer, this provides the opportunity to perceive deeper cultural meanings in the familiar urban environment, which become accessible through digital technologies.

Ethical Aspects of AI Use. The use of AI in working with cultural heritage raises questions about the ethical boundaries between the original and its digital interpretation. Generative algorithms can create new variations of façade elements or reconstruct lost fragments, but there is always a risk of substituting historical authenticity with the algorithm's creative interpretation. This raises the dilemma: where is the line between preserving heritage and creating its "virtual twin"? Concerns include:

- **Authenticity:** Digital interpretation may distort the architect's original intent or the historical context of the era.
- **Commercialization of heritage:** Cultural code may be turned into a decorative resource used for marketing, without respect for its historical value.
- **Responsibility for interpretation:** Algorithms trained on limited datasets may simplify or stereotype complex cultural symbols.

It should be noted that the ethical issues of digital reconstruction of cultural heritage are actively discussed in other European cities as well. In Vienna, projects on the digitization of modernist architecture are accompanied by strict methodological guidelines: digital copies are always labeled as reconstructions in order to avoid confusion with the original. In Barcelona, where the legacy of Antoni Gaudí is extensively studied and preserved, the principle of "careful interpretation" is applied–algorithms may supplement lost details, but the degree of authenticity of each element must be indicated. In Prague, when digitizing historical districts, emphasis is placed on the educational mission: digital models are primarily developed for schools and universities rather than for commercial purposes.

These examples demonstrate that the use of AI in working with architectural heritage requires not only technical solutions but also an ethical framework. International experience confirms the

necessity of transparency and of indicating the distinction between authentic objects and their digital interpretations, which helps to preserve public trust in digital projects (UNESCO, 2016, 2021).

Thus, it can be concluded that the ethics of working with digital heritage demand balance: technologies should support the preservation and interpretation of architecture, but not replace its real historical context. Therefore, the key task of researchers and curators in the contemporary environment is to establish transparent methodologies that make it possible to distinguish authentic heritage from its digital interpretations and to explicitly indicate this difference to the viewer. For a sustainable approach, it is essential to combine scholarly accuracy with respect for cultural authenticity, so that digital technologies complement rather than displace the historical context.

Formation of a New Urban Identity. AI performs not only an analytical function, helping "read" Riga's cultural code, but also becomes an active instrument in constructing a new urban identity. Contemporary digital projects, from virtual museums to interactive installations, create new experiences for residents and tourists. Architecture ceases to be a static monument and becomes a dynamic element of urban culture, interactable via digital media. AI thus mediates between past and present, linking historical heritage with contemporary forms of cultural expression.

If Art Nouveau in the early 20th century shaped the city's visual identity and reflected its aspiration for modernization and aesthetic cohesion, in the 21st century a similar role is played by digital technologies.

Firstly, AI facilitates the representation of cultural heritage. Through computer vision, 3D modeling, and generative design, Art Nouveau architecture becomes accessible in digital space: in virtual museums, interactive applications, and educational platforms. This changes the very perception of the city, it ceases to be merely a geographical location and becomes a network of cultural images available globally.

Secondly, it enables direct participation of residents and tourists in the cultural experience. Interactive AR and VR projects based on architectural data allow city dwellers to literally "try on" cultural heritage in their everyday experience. AI simplifies navigation through the symbolism and style of buildings, making the city's cultural code more comprehensible and engaging. This strengthens local identity and fosters a sense of participation in preserving and developing the cultural space.

Finally, a new image of Riga is formed in global cultural communication. Combining architectural traditions with digital interpretations allows Riga to position itself not only as a center of Art Nouveau but also as a laboratory for rethinking historical architecture through new media.

Thus, AI's role extends beyond an analytical tool: it becomes a factor influencing the collective perception of the city. Riga's new identity is built through a dialogue between historical heritage and digital practices, where artificial intelligence acts as a connecting link, uniting cultural past and contemporary aspirations for innovation.

Conclusion. The study of artificial intelligence applications in the analysis and interpretation of Riga's architecture demonstrates that digital technologies have become an essential tool not only for systematizing cultural heritage but also for rethinking it in a contemporary context. Computer vision and generative algorithms enable the identification of characteristic Art Nouveau motifs, the documentation of their repetition and variation, as well as the creation of new visual forms based on historical aesthetics.

At the same time, AI functions as a mediator of cultural experience: it makes the symbolic language of architecture accessible to a broad audience, expands the boundaries of urban perception, and fosters new forms of interaction with heritage through VR, AR, and digital artistic practices. Ethical considerations, distinguishing the authentic from the interpreted, and addressing the risks of distortion or commercialization, are essential for responsible use of these technologies, providing a framework for both scholarly and cultural work.

As a result, artificial intelligence not only aids in preserving and understanding Art Nouveau architecture but also becomes an active participant in shaping Riga's new urban identity. The combination of historical code and digital interpretations opens opportunities for reimagining the city as a cultural phenomenon where past and present converge in a unified space. Thus, AI acts not only as an analytical tool but also as a cultural intermediary, integrating heritage and innovation in the process of constructing the city's future image.

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