

## Chapter 9

# Machine Learning and Artificial Intelligence for Smart Visualization, Presentation, and Study of Architecture and Engineering in the Urban Environment: Visualizing City Progress

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### ABSTRACT

*This research experiments the theme of cultural heritage (CH) in architectural/engineering fields, located in urban space. Primary sources and new tactics for digital reconstruction allow interactive contextualization-access to often inaccessible data creating pedagogical apps for spreading. Digital efforts are central, in recent years based on new technological opportunities that emerged from big data, Semantic Web technologies, and exponential growth of data accessible through digital libraries – EUROPEANA. Also, the use of data-based BIM allowed the gaining of high-level semantic concepts. Then, interdisci-*

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*plinary collaborations between ICT and humanities disciplines are crucial for the advance of workflows that allow research on CH to exploit machine learning approaches. This chapter traces the visualizing cities progress, involving Duke and Padua University. This initiative embraces the analysis of urban systems to reveal with diverse methods how documentation/understanding of cultural sites complexities is part of a multimedia process that includes digital visualization of CH.*

## **INTRODUCTION**

This article will retrace the development of Visualizing Cities, an international research initiative involving Duke University, the University of Padua and the University of Venezia IUAV, which has evolved from the fundamental strategies developed by Visualizing Venice. Visualizing Venice is a research project instituted in 2012 by Caroline Bruzelius (Duke University) and Donatella Calabi (IUAV) in which the key aspect is collaboration and teamwork (Huffman et al., 2017). This collaborative aspect includes exhibitions, reviews, publications, lectures and invited presentations in Europe, United States, Asia. The collaboration of a range of multidisciplinary skills has been fundamental for this project: History of art, History of architecture and of the city, Representation (in particular Architectural survey, Building Information Modeling - BIM, Geographic Information System - GIS, Perspective and Photographic restitutions), Structural Engineering, Restoration and Conservation of buildings, Information and Communications Technology - ICT. In particular, Visualizing Venice included multiple theoretical / operational activities through the use of interoperable models and city views, reconstructions and interactive maps, such as models that not only have an academic value but are configured as accessible to a wider audience: the aim was therefore to make open and inclusive the study of the history of a complex city like Venice. Visualizing Cities is a consequent initiative that includes examining urban systems and sites not only within Venice, but also in Padua, Carpi, Athens, Krakow, continuing to demonstrate how documentation and understanding of cultural sites and their complexities may be assumed as part of a multimedia process that includes the interpretation of digital visualizations of historical monuments (Huffman, Giordano, 2019. Giordano, 2017. Giordano et al. 2018). Moreover, precisely by using digital methods, the time has come to deepen the scientific analysis of visual and written documents that validate and / or reveal previously unknown urban circumstances. The traditional methodologies of art, architecture and city history remain the very foundation of rigorous digital approaches; in fact, the study of a city and its architectural / engineering artefacts requires the academic organization of information and visual sources to connect with a wider historical context. Therefore, the availability of new digital tools and applications, iconographic and textual sources - primary data of exceptional value not only from an historical point of view, but also for interpretative reflections - can now intertwine as a scientific practice for advanced know-how and technologies for the visualization of historic cities. There is a demand for further scientific analysis of documents that validate and / or reveal urban circumstances. Traditional methodologies of architectural and urban history must remain the fundamental core of digital approaches; the study of a city will always require the academic decoding of information and visual sources that connect them to their wider context. In this sense, the integration of multiple skills is essential: the skills of art and architecture historians with those of architects / engineers and experts in visual and media studies. With all our research projects, art and architecture historians have conducted archival research that is fundamental to our understanding. In addition, with each of our projects, the process of building

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