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From Silence to Voice: Artificial Intelligence as an Interpreter of Architectural Memory

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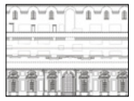
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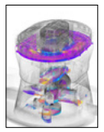
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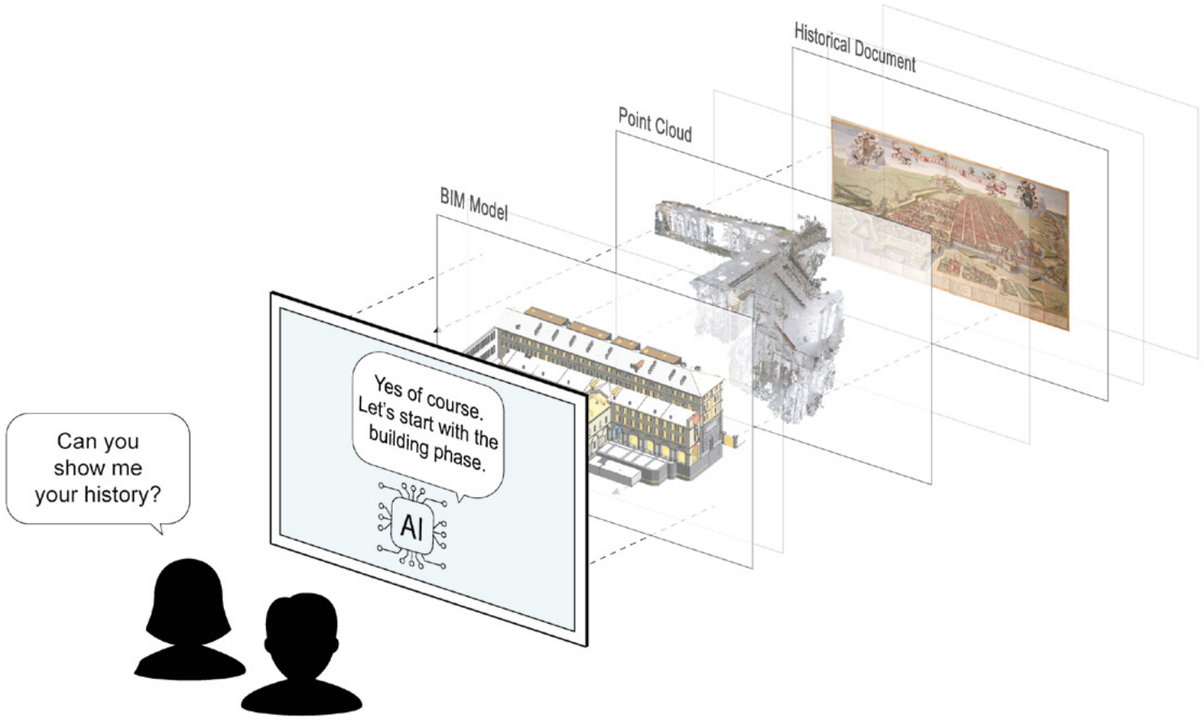


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00.
Interacting with the model

From Silence to Voice: Artificial Intelligence as an Interpreter of Architectural Memory

Dal silenzio alla parola: L'Intelligenza Artificiale come interprete della memoria degli edifici

Daniela Antonelli
Politecnico di Torino | daniela.antonelli@studenti.polito.it
Matteo Del Giudice
Politecnico di Torino | DISEG I matteo.delgiudice@polito.it
Fabio Manzone
Politecnico di Torino | DISEG I fabio.manzone@polito.it

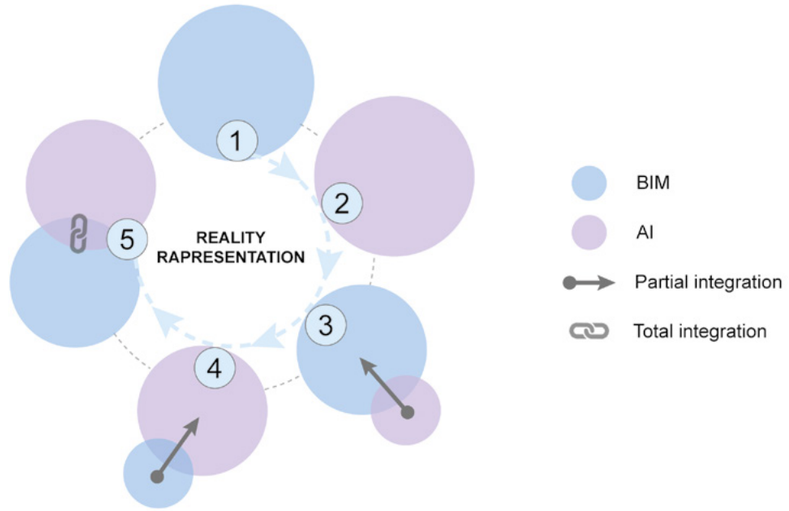
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"So architecture is not mute. It is a means of communication. This is a story about the depth of our passions. This is an impartial assessment of centuries now past." (Daniel Libeskind).
Inspired by this reflection, the present research proposes a model of open and accessible dialogue between humans and buildings through the integration of two innovative tools within the digitalization domain: Building Information Modelling (BIM) and Artificial Intelligence (AI). The proposed methodological framework unfolds through three phases that reflect the essential steps of a conversation: listening (Data Collection), interpretation (Data Restitution) and response (Data Interaction). Within this process, the building, conceived as an *archive of memory*, undergoes a conceptual metamorphosis, evolving from a "silent" entity to a "thinking" and finally to a "speaking" building. Interaction occurs through textual input that, once processed by Large Language Models (LLMs), queries the BIM model and returns outputs in natural language. The methodology aims to restore to cultural heritage the ability to narrate itself, fostering a renewed relationship between architecture and the community through digital intelligence.

"Quindi l'architettura non è muta. È un mezzo di comunicazione. Questa è una storia sulla profondità delle nostre passioni. Questa è una valutazione imparziale di secoli ormai passati." (Daniel Libeskind).
Prendendo spunto da questa riflessione la presente ricerca propone un modello di dialogo aperto e accessibile tra uomo ed edificio basato sull'utilizzo di due soluzioni innovative appartenenti al mondo della digitalizzazione: il Building Information Modelling e l'Intelligenza Artificiale. Il framework metodologico individuato si sviluppa in tre fasi che riprendono i passaggi chiave della conversazione: l'ascolto (Data Collection), l'interpretazione (Data Restitution) e la risposta (Data Interaction). In questo processo l'edificio, inteso come archivio di memoria, attraversa una metamorfosi concettuale, trasformandosi da edificio "silente" ad edificio "pensante" ed infine ad edificio "parlante". L'interazione avviene attraverso un imput testuale che, una volta interpretato modelli di Large Language Model (LLM), interroga il modello BIM restituendo risposte in linguaggio naturale. La metodologia proposta vuole restituire al patrimonio culturale la capacità di raccontarsi e di condividere la propria memoria con la collettività.

INTRODUCTION

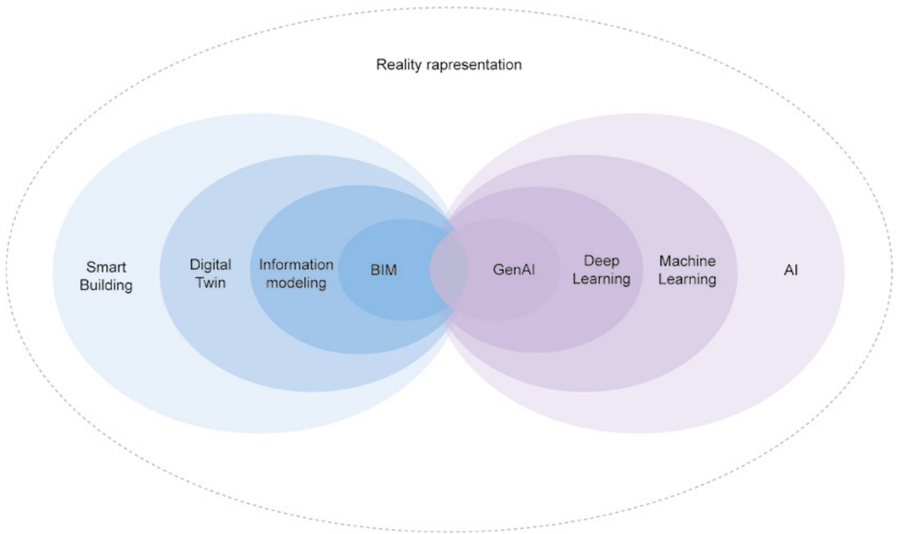
If historic buildings could "speak", what would they say?
Perhaps they would recount stories of those who built them, the transformations they have undergone, the people who have inhabited them and the roles they played throughout history. The cognitive phase of architectural analysis is precisely dedicated to listening to these voices. It is the moment when the observer engages in dialogue with the building, gathering information and transforming matter into data to support accurate assessment and informed intervention planning.
The representation of built heritage has undergone a profound transformation. What was once documented through drawings, surveys, archival deeds and photographs has progressively evolved into a digital ecosystem centered on optimization, advanced visualisation and knowledge dissemination through the use of 3D representation systems, the creation of navigable models, and thanks to careful management of data and metadata related to the asset [1].
Over the past few decades, Building Information Modelling has become the primary tool for representing, managing and documenting works of significant historical value [2]. When applied to heritage, BIM evolves into Historical Building Information Modelling (HBIM), where the physical building is translated into a digital model supporting decision-making across pre-construction, construction and post-construction stages. Recent research has highlighted both strengths and limitations of HBIM highlighting the presence of gaps in data acquisition, modelling a ccuracy and the adaptation of workflows to the intrinsic complexity of heritage assets [3].
To address these limitations and to broaden access to heritage information, recent research has increasingly turned to Artificial Intelligence (AI). AI, ranging from neural networks to Large Language Models, offers numerous advantages in terms of automation and process simplification, from recognising morphological patterns to identifying semantic correlations and generating predictive insights [4]. The integration of Building Information Modelling and Artificial Intelligence can therefore enable a real dialogue with the built heritage, allowing anyone to explore and question the memory embedded within the building.
Consequently, following the evolution of how buildings have been represented and interpreted over time, five progressive stages of interaction can be outlined, each enabling a deeper and more effective dialogue between humans and architecture: BIM, AI, AI for BIM, BIM for AI, and BIM together with AI [Fig.01.].



01.

Representation of the various possible interactions between BIM and AI

The latter represents the highest level of synergy: a state of complete synchronisation between the two technologies. Most existing research has focused on the first approach, where AI is employed to support BIM creation processes. A concrete example could be the semi-automated 3D reconstruction of geometries from point clouds using AI algorithms [5]. More recently, further research has been developed to show how Python scripts, generated by AI agents, can create parametric models for HBIM purposes and archaeology [6].
This research proposes to move beyond that stage, presenting a methodology that employs the BIM model as a *knowledge archive* to be interpreted by AI. The diagram shown in [Fig. 02.] illustrates the progressive convergence between BIM and AI, highlighting the distinctive components of each domain and the way they interact.
In this framework, AI acts as a mediator between the building and the user, translating complex information into natural language. Through this process, the building undergoes a transformation, evolving from a "silent" building to a "talking" building.



02.

Venn diagram showing levels of overlap between BIM and AI fields

THE CASE STUDY OF THE ROYAL CAVALRY OF TURIN

In the heart of Turin lies the Cavallerizza Reale, a building that has undergone multiple transformations over the course of nearly 300 years [7] [Fig.03.].
Built in the seventeenth century within the area once known as the "Command Zone" and illustrated in the "*Theatrum Sabaudiae*"(1682), the Cavallerizza continues to embody a dialogue between architecture and community. The first intervention, conducted by architect Amedeo di Castellamonte between 1680 and 1686, defined the four wings of the stables adjacent to the *Accademia dei Paggi*. Between 1740 and 1742, the project was entrusted to architect Benedetto Alfieri, who reconfigured the spaces of the *Maneggio*, the *Duca di Chiablese* and the *Rotonda* dome. In 1820, the north-east section was completed by engineer Giovanni Mosca, who designed a large building consisting of two connected wings: the first facing the Royal Gardens, while the second, transverse wing connects the first building to the Rotonda.
This sequence of expansions was interrupted in 1943, when the wings of the first two courtyards of the Cavallerizza were destroyed by aerial bombardment. Despite the historical significance of the complex, the area remained neglected for decades. Only in 2022, through the renewed interest of the Fondazione Compagnia di San Paolo, did the Cavallerizza embark on a new phase of regeneration.
Studying the Cavallerizza Reale therefore means engaging in a fragmented journey in which the building itself becomes the protagonist, a subject to be listened to, interpreted and made intelligent to the wider community. Artificial Intelligence, thanks to its versatility and accessibility, provides the means to achieve this goal: enabling anyone to listen to and interact with the building.

METHODOLOGY

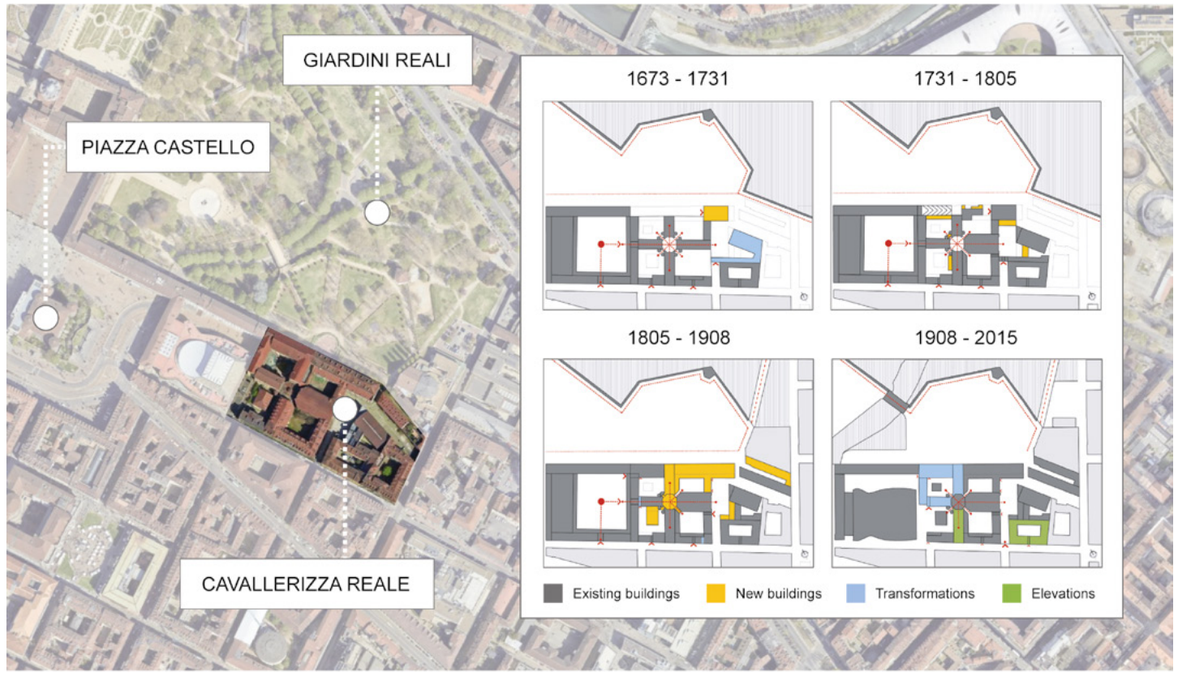
The proposed methodological framework is articulated into three main phases – Data Collection, Data Restitution and Data Interaction – metaphorically reflecting the stages of a conversation: listening, interpreting and responding.

Data Collection – Listening

In this initial phase, the building exists in its primitive state: the *silent building*.
Here, "Listening" takes the form of *observation* and consists of the systematic collection, integration and normalisation of data related to the building. This process follows a multidimensional approach, integrating 3D surveys, archival documentation, metric and stratigraphic investigation, which are systematically integrated into a shared digital environment (e.g. Common Data Environment - CDE). The relevance of the information may vary according to the quality and quantity of the available data found for the building, depending on these, parts of the building can be better defined and parts more unknown [8].
In this phase, the BIM model, created using a BIM authoring platform (e.g. Autodesk Revit), serves as the operational core of the digitalisation process.
More than a geometric container, it is conceived as an archive of relationships, where data are organised through parameters, phases and phase filters. Each model element thus acquires its digital biography, stored in a *Property set* [01] (*Pset*) that serves as a bridge between the past and the present.

Data Restitution – Interpretation

At this stage, the building conceptually evolves from a physical entity to a *thinking system*, capable of transforming data into knowledge.
The documentary data and BIM information are consolidated within a management platform which, through an *embedding* [02] process based on an OpenAI API [03], organises all content into a *Knowledge Graph*. This graph provides the semantic structure required to organise and relate the project's BIM and documentary data, drawing on the data-structuring capabilities demonstrated in knowledge-graph-based methods for construction process analysis [9]. Here, AI assumes an interpretative role, capable of extracting semantic meaning from technical data.



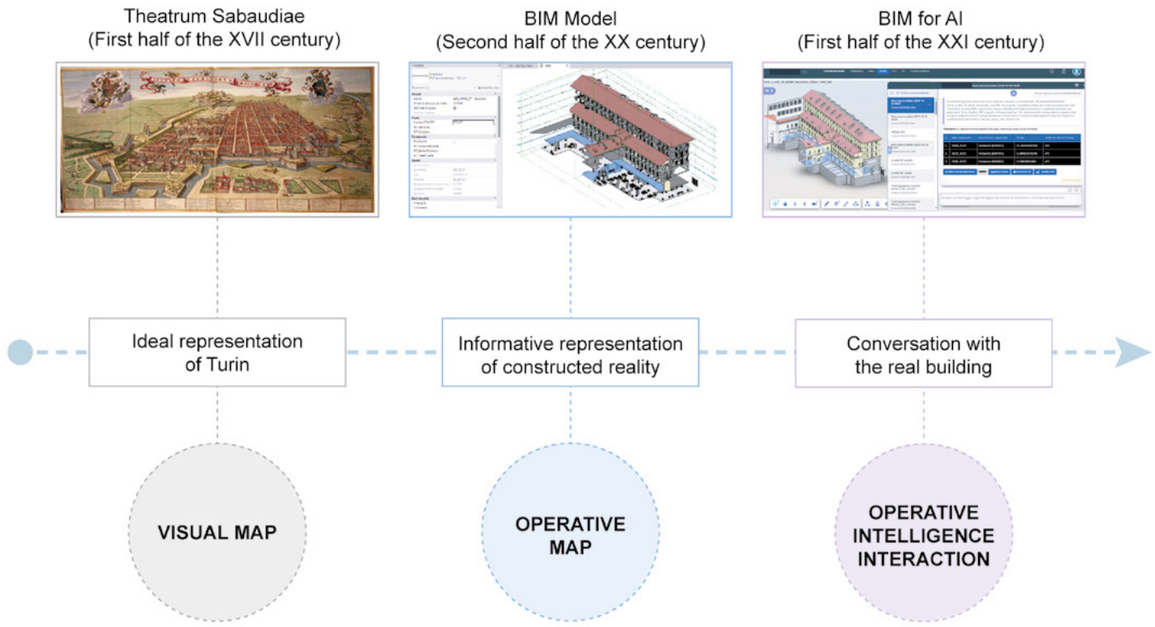
03.

Infographic reworking of diagrams taken from 'Architectural and Urban Design Laboratory 01F0V' depicting the transformations undergone by the Cavallerizza Reale in Turin, A. Magnaghi, E. Vigliocco, M. Pellegrino, V. Sibona, Faculty of Turin, Polytechnic School of Architecture.

This phase constitutes a cognitive passage in which digital data are re-elaborated and reinterpreted into structured, interpretable knowledge.

Data Interaction – The response

After creating a memory, the building reaches its final stage of transformation, becoming a *talking building*.
Conversational AI enables interaction between the Knowledge Graph and the user. Using a Large Language Model (e.g. Gemini Flash 2.5), trained on project-specific data, the system can respond to natural language queries. Users communicate via text *prompts* and the AI translates these into structured queries addressed to the Knowledge Graph. In practice, the AI agent will be asked to identify specific phases of the model, extract information, and compare sources and documents. The AI will respond in natural language, in tabular format (e.g. Excel tables), or as highlighted model components.
To ensure reliability, the AI agents draw exclusively on data contained within the Knowledge Graph, preventing *hallucinations* or fabricated output, problem that characterizes the use of GPT models [10].
While the experimental phase employed proprietary formats (.rvt), the long-term objective is to integrate OpenBIM standards (e.g. .ifc) in order to improve interoperability and cross-platform compatibility.
This phase represents the innovative core of the research: the transition from a purely visual and descriptive representation of heritage to an interactive and dialogical system in which the building "speaks" through its data. [Fig.04.] visually synthesizes this evolution, outlining the transition from the *Theatrum Sabaudiae* (second half of XVII century) as a visual map, to the BIM model (second half of XX century) as an operative map, and finally to the BIM AI integration (first half of XXI century) as an operative intelligence: a transformation from static visualization to dynamic interpretation, where the digital model becomes an active narrator of architectural memory.
The result is a cognitive, interactive and participatory experience: a new way of representing and, at the same time, understanding built heritage.



04.

Process of reality representation driven by graphical and alphanumerical data

CONCLUSIONS

In the context of cultural heritage, representation becomes a fundamental means of establishing dialogue. As architect Daniel Libeskind states in one of his interviews,
"Too often we wish everything were simple and clear to us. Of course, architecture is not a language of words. But this is language. A language that cannot be represented by letters or words".
Architecture thus constitutes a complex expressive system that must be interpreted, translated and narrated. Speaking to a building means "listening to its memory", transforming data into narrative and returning to the community a living, shared and accessible form of knowledge.
This research demonstrates that, when the informational model is well-structured and interoperable, AI can serve as an effective mediator between built heritage and its users.
The integration of BIM and AI may indeed mark a paradigm shift in the representation of buildings: from a merely descriptive tool to a platform of interaction and participation. Nonetheless, it remains crucial to avoid reducing the complexity of construction to mere automatic simplification and abstraction, ensuring that AI operates within a framework of contextualisation, transparency and shared authorship.
Current limitations include the application to a single case study and the use of proprietary formats (rvt), which restrict interoperability and generalizability.
Future developments will focus on three key directions: expanding the framework to additional case studies, integrating OpenBIM standards, and developing shared ontologies for HBIM representation integrated with LLM, with the ultimate goal of making cultural heritage not merely *visible*, but truly *conversant*.
In this perspective, representation not only becomes a means of dialogue, but a shared cognitive experience between building, knowledge and community.

AKNOWLEDGEMENTS

Authors thanks Fondazione Compagnia di Sanpaolo, Secap S.p.a., Brains Digital and BimPool-Ai to support the active research.

NOTES

01| Property Set: The IfcPropertySet is a container that holds properties within a property tree (https://standards.buildingsmart.org, retrieved at 30/10/2025)
02| Embedding is a means of representing objects such as text, images, and audio as points in a continuous vector space, where the positions of these points in space are semantically meaningful to machine learning (ML) algorithms. (https://www.ibm.com/it-it/think/topics/embedding , retrieved at 30/10/2025)
03| An API, or application programming interface, is a set of rules or protocols that enable software applications to communicate with each other to exchange data, features and functionality (https://www.ibm.com/it-it/think/topics/api, retrieved at 30/10/2025)

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