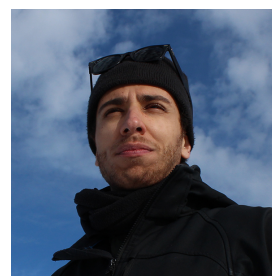# Lorenzo Cardarelli - Curriculum Vitae

13th February 2025

Born: 24th July 1995

Place of birth: Rome

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Bibliography and research interests

I am an archaeologist specialising in quantitative andd protohistoric Italian archaeology. I completed both my Bachelor's (2017) and Master's degrees (2019) at the Sapienza University of Rome, where I focused on analysing ceramic materials from the protohistoric settlement of Monte Cimino (Viterbo, Italy). In 2020, I began a fully funded PhD at the University of Bari Aldo Moro, developing a pioneering project titled "Variability and standardisation of vessel shapes in the 2nd and first half of the 1st millennium BC in continental Italy: a Data Science and Machine Learning project for the quantitative study of archaeological ceramic profiles." My research experience includes a visiting researcher position at the Österreichisches Archäologisches Institut in Vienna, Austria (March-June 2022), followed by an associate researcher role at the CNR - Istituto di Scienze del Patrimonio Culturale, Area della Ricerca Roma 1 (April 2022-September 2023). Most recently, I served as a post-doctoral research fellow at the Sapienza University of Rome (2023-2024), where I contributed to the PRIN 2020 project "HERDS. Animal Husbandry and its Economic Role in the Development of Central Mediterranean Protohistoric Societies." In this role, I conducted GIS analysis, managed databases, and performed statistical analysis of zooarchaeological data. I combine traditional archaeological methods with cutting-edge technological approaches, including quantitative methods, computer science tools, and statistical programming. My technical expertise extends to machine learning and deep learning applications for material classification, territorial analysis, database management, and the dissemination of research findings through dynamic web documentation. My research interests focus on material culture and societies from the Bronze Age to the Early Iron Age in Italy. Beyond my comprehensive knowledge of protohistoric Italian material culture and social dynamics, I have developed expertise in 3D modeling and rendering software for reconstructing and visualising archaeological contexts.

Research interest

- Quantitative and computational archaeology.

- Machine Learning application in archaeology.

- Bronze and Iron Age of Italy.

- 3D reconstruction of pre- and protohistoric environments

- GIS application in archaeology.

Skills

- Knowledge of software for 3D modeling and rendering of archaeological materials (Blender, Unreal Engine 5).

- Programming languages (R, Python) with a specific focus on statistical aspects and data analysis (NumPy, Pandas, Scikit-learn, tidyr), plotting and data visualisation (Matplotlib, Seaborn, Plotly, ggplot2), network analysis (NetworkX).

- Familiarity with frameworks for neural network development (Pytorch).

- Proficiency in languages for creating and publishing scientific documentation (LaTeX, Markdown, Quarto) and generic web development (HTML, CSS).

- Understanding of the GIS environment (Qgis, SAGA), including geoprocessing, raster analysis and integration with programming languages (Rasterio, Folium, Geopandas).

- Database processing using SQL

- In-depth knowledge of Bronze Age and Early Iron Age societies and culture in Italy.

- Proficiency in version control software (Git)

Education

11/2020 – 11/2023	**PhD**	📍 *Bari, Italy*

Aldo Moro University
PhD course in *Patrimoni archeologici, storici, architettonici e paesaggistici mediterranei*
Project title: *Variability and standardisation of vessel shapes in the 2nd and first half of the 1st millennium BC in continental Italy: a Data Science and Machine Learning project for the quantitative study of archaeological ceramic profiles*

In the context of my PhD, the topics I extensively explored and the tools I utilised included:

- Statistical analysis.

- SQL database management.

- Python programming.

- Version control using Git.

- Development of Deep Learning architectures.

- Territorial analysis through GIS.

- Creation of dynamic and accessible documentation via web frameworks.

- Documentation and digitization of extensive archaeological materials.

- Analysis of social components through material culture.

Tutor: Dr Marco Bettelli
Grade: Excellent with honours

2019	**Master's degree in Archaeology (LM-02)**	📍 *Rome, Italy*

Sapienza, University of Rome
Thesis title: *Produzione vascolare dalla vetta del Monte Cimino (VT)*
During the thesis work, I undertook the following tasks:

- Technical drawing of approximately 750 ceramic fragments.

- Material management using a relational SQL dataset.

- Statistical and quantitative analysis of the ceramic material.

- Typological analysis of the material and comparisons with contemporaneous sites.

- Social analysis of the context based on the archaeological record.

Supervisors: Prof Andrea Cardarelli, Dr Barbara Barbaro
Grade: 110 with honours/110

2017	**Bachelor's Degree in Archaeological Sciences (L-01)**	📍 *Rome, Italy*

Sapienza, University of Rome
Thesis title: *Produzione vascolare dal contesto cultuale del Monte Cimino (VT)*

During the thesis work, I undertook the following tasks:

- Technical drawing of 350 ceramic fragments.

- Material management using a relational SQL dataset.

- Typological analysis of the material and comparisons with contemporaneous sites.

- Social analysis of the context based on the archaeological record.

Supervisor: Prof Andrea Cardarelli
Grade: 110 with honours/110

Work experience

09/2024 – 11/2024	**Archaeological excavation**	📍 *Fratta Polesine (RO), Italy*

Dipartimento di Scienze dell'Antichità - Sapienza University of Rome, Piazzale Aldo Moro 5
Archaeological excavation of the protohistoric settlement of Frattesina (Fratta Polesine, RO) Directors: Prof. Andrea Cardarelli, Sapienza University of Rome; Prof. Paolo Bellintani, Soprintendenza per i Beni Archeologici della Provincia Autonoma di Trento.
Archaeological operator; Compilation of US sheets; Reliefs and photoplans; Laboratory and cataloguing activities.
Società Archeologica SAP. Via Fienili 39/a, 46020 Quingentole, Mantova (MN)

12/2023 – 11/2024	**Research fellowship**	📍 *Rome, Italy*

Dipartimento di Scienze dell'Antichità - Sapienza University of Rome, Piazzale Aldo Moro 5
Research grant within the **PRIN 2020** project **HERDS. Animal Husbandry and its Economic Role in the Development of Central Mediterranean Protohistoric Societies**.
GIS and statistical analysis, communication and presentation of results through web frameworks, query and management of database, plotting, bioinformatic analysis.

09/2023 – 10/2023	**Archaeological excavation**	📍 *Fratta Polesine (RO), Italy*

Dipartimento di Scienze dell'Antichità - Sapienza University of Rome, Piazzale Aldo Moro 5
Archaeological excavation of the protohistoric settlement of Frattesina (Fratta Polesine, RO) Directors: Prof. Andrea Cardarelli, Sapienza University of Rome; Prof. Paolo Bellintani, Soprintendenza per i Beni Archeologici della Provincia Autonoma di Trento.
Archaeological operator; Compilation of US sheets; Reliefs and photoplans; Laboratory and cataloguing activities.
Società Archeologica SAP. Via Fienili 39/a, 46020 Quingentole, Mantova (MN)

09/2022 – 10/2022	**Archaeological excavation**	📍 *Arcevia (AN), Italy*

Archaeological excavation 📍 *Arcevia (AN), Italy*
Dipartimento di Scienze dell'Antichità - Sapienza University of Rome
Archaeological excavation of the protohistoric settlement of Monte Croce-Guardia (AN)
Director: Prof. Andrea Cardarelli, Sapienza University of Rome.
Archaeological operator; Compilation of US sheets; Reliefs and photoplans; Laboratory and cataloguing activities.
Archeosistemi Cooperative Society. Via Nove Martiri, 11/A 42124 Reggio Emilia (RE)

09/2021 – 12/2021   **3D reconstructions of buildings and artefacts** 📍 *Rome, Italy*
Dipartimento di Scienze dell'Antichità - Sapienza, University of Rome, Piazzale Aldo Moro 5
Realisation of 3D reconstructions of dwellings and artefacts from the protohistoric settlement of Monte Croce-Guardia (AN) for the video "*Il villaggio protostorico di Monte Croce Guardia 1200-950 a.C.*", presented in "*Se tremila anni sembran tanti... Il villaggio protostorico di Monte Croce Guardia - Arcevia 1200-950 a.C.*" (Arcevia - AN, 09/07/2022).
Using a completely open-source framework, a series of dwellings discovered during archaeological investigations were reconstructed in a philological manner. This reconstruction included material selection, modeling texturing, and was achieved through the analysis of archaeological documentation from the site, as well as from contemporaneous or comparable contexts. Additionally, a wide range of materials, such as ceramics, weaponry, tools, and furniture, were meticulously reconstructed.

09/2021 – 11/2021   **Archaeological excavation** 📍 *Arcevia (AN), Italy*
Dipartimento di Scienze dell'Antichità - Sapienza, University of Rome, Piazzale Aldo Moro 5
Archaeological excavation of the protohistoric settlement of Monte Croce-Guardia (AN)
Director: Prof. Andrea Cardarelli, Sapienza University of Rome.
Archaeological operator; Compilation of US sheets; Reliefs and photoplans; Laboratory and cataloguing activities.
Archeosistemi Cooperative Society. Via Nove Martiri, 11/A 42124 Reggio Emilia (RE)

09/2020 – 11/2020   **Archaeological excavation** 📍 *Arcevia (AN), Italy*
Dipartimento di Scienze dell'Antichità - Sapienza, University of Rome, Piazzale Aldo Moro 5
Archaeological excavation of the protohistoric settlement of Monte Croce-Guardia (AN)
Director: Prof. Andrea Cardarelli, Sapienza University of Rome.
Archaeological operator; Compilation of US sheets; Reliefs and photoplans; Laboratory and cataloguing activities.
Akhet S.R.L., Closellinaz, 44/A, 11010 Roisan (AO)

Publications

Preprint 2025	**PyPotteryInk: One-Step Diffusion Model for Sketch to Publication-ready Archaeological Drawings** Cardarelli L., *arXiv:2502.06897*
Journal article 2025 *ANVUR A-rated, area 10*	**Chert sources and territorial behaviour after the Neolithization process: An exploratory analysis from Grotta Battifratta (Rieti, Central Italy)** Carletti E., Conati Barbaro C., Allegretta I., Cardarelli L., Forti L., Monno A., Terzano R., Eramo G. *Quaternary International*, 717
Preprint 2024	**PyPotteryLens: An Open-Source Deep Learning Framework for Automated Digitisation of Archaeological Pottery Documentation** Cardarelli L., *arXiv:2412.11574*
Book section 2024	**Vessel typological classification: comparing archaeologist perspectives to a digital approach** Cardarelli L., Erbetti F., Paniccia C., Paolini E. *Studi in onore di Andrea Cardarelli*, Naus Editoria
Book 2024	**Morphological variability and standardisation of vessel shapes in the 2nd and first half of the first millennium BC in continental Italy. A data science and machine learning project for the quantitative study of archaeological ceramic profiles** Cardarelli L., *Edipuglia*, ISBN 979-12-5995-084-0

Journal article 2024 *ANVUR A-rated, area 10*	**From fragments to digital wholeness: an AI generative approach to reconstructing archaeological vessels** Cardarelli L., *Journal of Cultural Heritage*, 70
Journal article 2024 *ANVUR A-rated, area 10*	**CQARCHAEO: a python package for cosine quantogram analysis and Monte Carlo simulations.** Lago G., Cardarelli L., Ialongo N., *Archeologia e Calcolatori*, 35.1
Journal article 2023 *ANVUR A-rated, area 10*	**The Late Bronze age hilltop site of Monte Croce Guardia in the context of Bronze Age and Early Iron Age settlement organization in Peninsular Italy.** Cardarelli A., Di Renzoni A., Bettelli M., de Neef W., Scacchetti F., Cardarelli L., Paniccia C., Paolini E., *Origini*, XLVII
Journal article 2023 *ANVUR A-rated, area 10*	**Traditional and digital typologies compared: the example of Italian protohistory.** Cardarelli L., *Origini*, XLVII
Journal article 2023 *ANVUR A-rated, area 10*	**Defining Southern Etruria Final Bronze Age settlement models using an integrated GIS and machine learning approach.** Cardarelli L., *Archeologia e Calcolatori*, 34, 2
Journal article 2023 *ANVUR A-rated, area 10*	**Tracing the human movements of three thousand years ago by volcanic grinding tools in the Final Bronze Age settlement of Monte Croce Guardia (Arcevia-Marche Region, central Italy)** Santi P., Cardarelli A., Bettelli M. Di Renzoni A., Cardarelli L., Paniccia C., Renzulli A., *Scientific Reports* 13, 7022
Journal article 2023	**Money or ingots? Metrological research on pre-contact Ecuadorian "axe-monies"** Montalvo Puente C. E., Lago G., Cardarelli L., Pérez Molina J. C., *Journal of Archaeological Science: Reports*, 49
Journal article 2022 *ANVUR A-rated, area 10*	**A deep variational convolutional Autoencoder for unsupervised features extraction of ceramic profiles. A case study from central Italy.** Cardarelli L., *Journal of Archaeological Science*, 144
Journal article 2022 *ANVUR A-rated, area 10*	**Dimensionality reduction for data visualization and exploratory analysis of ceramic assemblages** Cardarelli L., Lapadula A., *Archeologia e Calcolatori*, 33, 2
Journal article 2020 *ANVUR A-rated, area 10*	**Capienza delle forme vascolari, da un metodo open source all'uso di modelli regressivi: il caso dell'insediamento protostorico del Monte Cimino** Cardarelli L., *Archeologia e Calcolatori*, 31, 1

Experience gained during university education

09/2019 – 11/2019; 09/2018 – 11/2018; 09/2017 – 11/2017; 09/2016 – 11/2016; 09/2015 – 11/2015	**Archaeological excavation** ⚲ *Arcevia (AN), Italy* *Sapienza University of Rome, Piazzale Aldo Moro 5* Archaeological excavation of the protohistoric settlement of Monte Croce-Guardia (AN) Director: Prof. Andrea Cardarelli, Sapienza University of Rome. Archaeological operator; Compilation of US sheets; Reliefs and photoplans; Laboratory and cataloguing activities.

06/2016 – 07/2016; 06/2015 – 07/2015	**Archaeological excavation** 📍 *Soriano nel Cimino (VT), Italy*

Archaeological excavation   📍 *Soriano nel Cimino (VT), Italy*
Sapienza University of Rome, Piazzale Aldo Moro 5
Archaeological excavation of the settlement and place of worship at Monte Cimino (VT). Director: Prof. Andrea Cardarelli, Sapienza University of Rome.
Archaeological operator; Compilation of US sheets; Reliefs and photoplans; Laboratory and cataloguing activities.

11/2019   **Systematic archaeological survey**   📍 *Fratta Polesine (RO), Italy*
Sapienza University of Rome, Piazzale Aldo Moro 5
Systematic archaeological survey of the protohistoric settlement of Frattesina di Fratta Polesine (RO). Director: Prof. Andrea Cardarelli, Sapienza University of Rome.
Archaeological operator; Laboratory and cataloguing activities.

01/2017 – 11/2017; 01/2019 – 12/2019   **Laboratory work on archaeological material**   📍 *Rome, Italy*
Sapienza University of Rome, Piazzale Aldo Moro 5
Laboratory activities on archaeological material from the protohistoric settlement of Monte Cimino (VT).
Drawing ceramic materials; Cataloging via SQL database.

Conference talks

2024	**30th EAA annual meeting** New perspective in quantitative archaeology: data driven approaches in pottery analysis, Cardarelli L., Rome, 28th - 31th August 2024
2024	**30th EAA annual meeting** New directions in chert provenance: towards new basis for detecting mobility ad territorial behaviour in central Italy during prehistory, Carletti E., Eramo G., Cardarelli L., Forti L., Allegretta I., Monno A., Conati Barbaro C., Rome, 28th - 31th August 2024
2024	**30th EAA annual meeting** Presentation of the project "Southern Ecuador and Northern Peru as an Andrean interface (AD 500-1532)", Lara C., Cardarelli L., Lago G., Montalvo C., Tacconi S., Costantine A., Rome, 28th - 31th August 2024
2023	**Conversation - Museo Numismatico, Banco Central del Ecuador** Avances sobre los estudios de las hachas-monedas, Montalvo Puente C. E., Lago G., Cardarelli L., Pérez Molina J. C., Quito (ECU), 23 july 2023
2023	**13° International Congress on the Archaeology of the Ancient Near East (ICAANE)** Workshop Serialising, standardising, specialising: Investigating a techno-social nexus underlying social complexity. Cardarelli L., Computerised approaches for investigating the morphological standardization ofArslantepe VI A pottery, Copenhagen, 24 may 2023.
2020	**IAS – Incontri di Archeologia 2020. Digital Humanities Session I-II** Cardarelli L., Capienza delle forme vascolari, un metodo basato su strumenti e formati open source che include l'uso di modelli regressivi: il caso dell'insediamento protostorico del Monte Cimino. Rome, 19 november 2020.

Associations

04/2022 – 09/2023	**Associate researcher** 📍 *Rome, Italy*

CNR - Istituto di Scienze del Patrimonio Culturale, Area della Ricerca Roma 1
Staff Prehistory and Protohistory Research Group; Staff MAD-Lab | Modelling Archaeological Data
Position held within the **PRIN 2020** project "**Mobility, Social Integration, and Culture Change in the Mediterranean Bronze Age**" with a specific focus on GIS analysis related to territorial movement using statistical programming, including statistical and network analysis.

02/2024 – *present*   **Member**   ⚲
                         Istituto Italiano di Preistoria e Protostoria

Packages

CQArchaeo   A Python package for calculating and plotting Kendall CQA results (Cosine quantogram analysis).
`https://github.com/lrncrd/CQArchaeo`

PyPotteryLens   A Python package with a graphical interface for the automatic filing of archaeological ceramics from PDFs
`https://github.com/lrncrd/PyPottery`

PyPotteryInk   A deep learning Python package for automating the digital inking process of archaeological pottery drawings
`https://github.com/lrncrd/PyPotteryInk`

Didactic activity

03/2024   **Machine learning e computer science in archeologia: tematiche, applicazioni e prospettive** Introductory seminar on Machine Learning and computer science in Archaeology, for PhD students of the XXXVII Cycle in Archaeology, Sapienza University of Rome

02/2022   **Python vs R - An archaeological challenge** Applied programming languages course to archaeology. XXXVI and XXXVII cycle of the Doctorate in *Patrimoni archeologici, storici, architettonici e paesaggistici mediterranei*. University of Bari 'Aldo Moro'.

03/2021   **QGIS basic course** Basic QGIS application to archaeology. XXXVI cycle of the Doctorate in *Patrimoni archeologici, storici, architettonici e paesaggistici mediterranei*. University of Bari 'Aldo Moro'.

Editorial work

Peer-review   Journal of Archaeological Science; PLOS ONE; Computer Applications and Quantitative Methods in Archaeology (CAA) - Conference

International experience

03/2022 – 07/2022   **Visiting Researcher**   ⚲ *Vienna, Austria*
                       Österreichisches Archäologisches Institut

Funding and grants

| **2020 – 2023** | PhD scholarship, Aldo Moro University, Bari. €45000 approx. |

IT skills

OS	Windows GNU-Linux
Office & Editing	Microsoft Office Adobe Photoshop Adobe Illustrator Adobe InDesign GIMP
Editing video & content creation	Adobe Premiere Pro Adobe AfterEffects
GIS Softwares	Qgis Arcgis SAGAgis
Version control	Git
Database	Microsoft Access
Programming & markup	R Python HTML CSS Markdown Bash SQL LaTeX
Statistical software	Past SPSS
Computer graphics	Blender Unreal Engine 5 Unreal Engine 4 Quixel Mixer Substance Painter Armor Paint

Language Skills

Italian	Native
English	Intermediate

Additional information

Driving Licence	B