



Department
of Excellence
2023 - 2027

LEMbeDS

Economics, Management and
Law in the era of Data Science

L'EMbeDS

**DEPARTMENT OF EXCELLENCE FOR ECONOMICS,
MANAGEMENT AND LAW IN THE ERA OF DATA SCIENCE**

ANNUAL REPORT 2023



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1. A BRIEF INTRODUCTION TO L'EMbeDS: A DEPARTMENT OF EXCELLENCE FOR ECONOMICS, MANAGEMENT AND LAW IN THE ERA OF DATA SCIENCE

L'EMbeDS is an acronym that, referring to a notion of embedding/inclusion, represents our overarching goal of exploiting opportunities fostered by Data Science (DS) in the disciplines of Economics (E) Management (M) and Law (L) – leveraging data and tools to bridge the gaps that still exist between complex models, their empirical validation, and their use in policy. Within the path delineated by research funding and engagement initiatives at the Italian, European and United Nations levels, our scientific aim is to better understand the relationships between innovation, employment, growth, environmental and social sustainability. Our policy aim is to identify public- and private-sector strategies to manage socio-economic and environmental change, and the corresponding evolution of our welfare systems.

For each of these areas, opportunities and challenges afforded by contemporary big data are key. Data availability, as well as the possibility of integrating information from multiple sources, are rapidly growing. Exploiting these opportunities to spur major research progress requires sophisticated modeling approaches and state-of-the-art statistical and computational tools to gather, integrate and analyze big data. Our groups pioneer many such approaches and tools. L'EMbeDS comprises faculty, researchers and students from the Institute of Economics, the Institute of Management and the DIRPOLIS Institute at the Sant'Anna School for Advanced Studies.

We have an established track record of translating research into measurable socio-economic impact through policies in support of innovation, growth and social mobility, environmentally sustainable production and consumption protocols, and effective and efficient healthcare systems. Finally, and importantly, we interact closely with the public and private sector on issues related to innovation, organizational change and new business models – with projects in the biomedical and healthcare sectors, the manufacturing sector, the banking and insurance sectors, and the manufacturing sector at large. We work with small and large companies, as well as a variety of institutional partners.

More information and details about L'EMbeDS, and activities and achievements during 2023, can be found below and at our website: <https://www.santannapisa.it/it/dipartimenti-eccellenza/L'EMbeDS>.

2. HIGHER EDUCATION: PhD PROGRAMS ASSOCIATED WITH L'EMbeDS

In the second funding cycle, L'EMbeDS will finance a total of 20 PhD scholarships, distributed as follows:

- 10 to the national PhD in AI & Society coordinated by UniPi (5 on ministerial resources, 5 on SSSA resources);
- 4 to the PhD in Economics at SSSA (ministerial resources);
- 4 to the PhD in Management, Innovation, Sustainability & Healthcare at SSSA (ministerial resources);
- 2 to the PhD in Health Science, Technology and Management at the SSSA (ministerial resources).

The national doctorate PhD-AI.it (<https://www.phd-ai.it/>) comprises 5 federated PhD programs that bring together 61 organizations, including universities and research centers. The 5 programs share a common basis in the foundations and methodological aspects of AI, each developing an area of specialization in a strategic application sector. Each program is coordinated by a lead university, in collaboration with the National Research Council. Following a national selection procedure, in 2021 SSSA became one of the 8 partner institutions of the PhD AI & Society coordinated by UniPi. The faculty of this program includes numerous



members of the L'EMbeDS community. For the 39th cycle, we recruited Dr. Bushipaka (MUR funding) and Dr. Mazzi (SSSA funding); see <https://www.santannapisa.it/it/news/we-welcome-three-new-students-national-phd-ai-society>. We also recruited two additional students: Dr. Porcedda, whose scholarship will be funded for 2/3 by PNRR funds and for 1/3 through residuals from the first cycle of the Department of Excellence, and Dr. Punzo, a supernumerary student without scholarship.

Concerning the doctoral programs administered by SSSA, for the 39th cycle we recruited Dr. Swaminathan to the PhD in Management, Innovation, Sustainability & Healthcare (MUR funding) and Dr. Di Carlo to the PhD in Economics (MUR funding); see <https://www.santannapisa.it/it/news/we-welcome-two-new-phd-students-economics-and-management-programs>.

3. EDUCATION AND RESEARCH-RELATED ACTIVITIES: VISITORS

We routinely host visiting faculty and researcher with the aim of further increasing international projection, exposing students to cutting-edge research and facilitating scientific collaborations. During 2023, we supported three such visitors; namely, Prof. Shapira of the University of Manchester, Prof. Scheinkman of the Columbia University of New York (<https://www.santannapisa.it/it/news/two-lectures-prof-scheinkman-scheduled-june-26-and-27-2023-santanna-school>) and Prof. Molinari of Auburn University, AL USA (<https://www.santannapisa.it/it/news/inferential-solutions-stochastic-processes-differential-privacy-and-multi-model-paradigms-and>).

4. EDUCATION AND RESEARCH-RELATED ACTIVITIES: WORKSHOPS AND MEETINGS RELATED TO L'EMbeDS

During 2023, L'EMbeDS members attended and participated to the organization of two workshops:

- The L'EMbeDS Kick-off Workshop, marking the start of the Department of Excellence's second cycle (<https://www.santannapisa.it/it/news/lembeds-kick-march-3rd-2023-starting-400pm>), held at SSSA in March 2023.
- The workshop "The fight against corruption: the potential of analysis tools between availability of big-data sources, privacy constraints and interoperability needs" (<https://www.santannapisa.it/it/news/il-contrasto-alla-corruzione-le-potenzialita-degli-strumenti-di-analisi-tra-disponibilita-di>), held at SSSA in October 2023.

Moreover, L'EMbeDS co-financed the REGIS Summer School (<https://www.santannapisa.it/it/news/regis-summer-school-science-technology-and-innovation>), held at SSSA in June 2023, and the "Dynamic Optimization in Economics and Finance" Summer School, for which we supported one of the invited faculty, Prof. Salvatore Federico of the University of Bologna.



5. EDUCATION AND RESEARCH-RELATED ACTIVITIES: SELECTED ARTICLES, MANUSCRIPT AND CONFERENCES

ARTICLES and MANUSCRIPTS

Faculty, researchers and students belonging to the L'EMbeDS community published several articles in peer-reviewed outlets in 2023. Neglecting bibliometrics (which is hardly indicative within a 1-year span), we report below a selection of those which we consider of high potential impact for the research areas covered by L'EMbeDS (first author alphabetical order):

- Amendola N., Gabbuti G., Vecchi G. (2023). "On some problems of using the Human Development Index in economic history". *European Review of Economic History*. (DOI: 10.1093/ereh/head008).
- Amram D. (2023). "La transizione digitale delle vulnerabilità e il sistema delle responsabilità". *Rivista italiana di medicina legale e del diritto in campo sanitario* (2023, 1 ff).
- Amram D. (2023). "Comparing EU Initiatives on Data: Addressing Risks and Enhancing Harmonisation Opportunities". *Opinio Juris in Comparatione* (2023, 1ff).
- Amram D. ed (2023) "Governo dei dati, Open AI e salute: profili introduttivi", *Rivista italiana di medicina legale e del diritto in campo sanitario* 2, p. 293. Focus including 5 papers: Carnat I., "Il compromesso di ChatGPT per il contenzioso civile: dall'affidabilità alla responsabilità"; Nasi C., "Generative AI: il futuro della medicina tra opportunità e sfide per i diritti fondamentali"; D'Elia C., "Gli strumenti di intelligenza artificiale generativa nel contesto sanitario: problemi di ottimizzazione delle risorse e questioni di spiegabilità"; Fiorinelli G., "Il concorrente virtuale: la prevenzione dell'uso di ChatGPT per finalità criminali tra etero- e auto-regolazione".
- Argyris G., Lluch Lafuente A., Tribastone M., Tschaikowski M., Vandin A. (2023). "Reducing Boolean networks with backward equivalence". *BMC Bioinformatics*. (DOI: 10.1186/s12859-023-05326-9)
- Argyris G., Luch Lafuente A., Leguizamon Robayo A., Tribastone M., Tschaikowski M., Vandin A. (2023). "Minimization of Dynamical Systems over Monoids". *38th Annual ACM/IEEE Symposium on Logic in Computer Science*. (DOI: 10.1109/LICS56636.2023.10175697).
- Bottazzi G., Cordonì F., Livieri G., Marmi S. (2023). "Uncertainty in firm valuation and a cross-sectional misvaluation measure". *Annals of Finance*. (DOI: 10.1007/s10436-022-00423-w).
- Bottazzi G., Giachini D., Ottaviani M. (2023). "Market selection and learning under model misspecification". *Journal of Economic Dynamics and Control*. (DOI: 10.1016/j.jedc.2023.104739).
- Calzolari G., Campolo M.G., Di Pino A., Magazzini L. (2023). "Assessing individual skill influence on housework time of Italian women: an endogenous-switching approach". *Statistical Methods and Applications*. (DOI: 10.1007/s10260-022-00672-z)
- Cantarelli, P., Vainieri, M., & Seghieri, C. (2023). "The management of healthcare employees' job satisfaction: optimization analyses from a series of large-scale surveys". *BMC Health Services Research*, 23(1), 1-14 (DOI: <https://doi.org/10.1186/s12913-023-09426-3>).
- Cardelli L., Grosu R., Larsen K.G., Tribastone M., Tschaikowski M., Vandin A. (2023). "Algorithmic minimization of uncertain continuous-time Markov chains". *IEEE Transactions on Automatic Control*. (DOI: 10.1109/TAC.2023.3244093).
- Cardelli L., Squillace G., Tribastone M., Tschaikowski M., Vandin A. (2023). "Formal lumping of polynomial differential equations through approximate equivalences". *Journal of Logical and Algebraic Methods in Programming*. (DOI: 10.1016/j.jlamp.2023.100876).



- Chai A., Stepanova E., Moneta A. (2023). "Quantifying expenditure hierarchies and the expansion of global consumption diversity". *Journal of Economic Behavior & Organization*. (DOI: 10.1016/j.jebo.2023.07.012).
- Ciarli T., Coad A., Moneta A. (2023). "Does Exporting Cause Productivity Growth? Evidence from Chilean Firms". *Structural Change and Economic Dynamics*. (DOI: 10.1016/j.strueco.2023.04.015).
- Coronese M., Occelli M., Lamperti F., Roventini A. (2023). "AgriLOVE: agriculture, land-use and technical change in an evolutionary, agent-based model". *Ecological Economics*. (DOI: 10.1016/j.ecolecon.2023.107756).
- Corsini F., Annesi N., Annunziata E., Frey M. (2023). "Exploring success factors in food waste prevention initiatives of retailers: the critical role of digital technologies". *British Food Journal*. (DOI: 10.1108/BFJ-01-2023-0034).
- Costa S., De Santis S., Dosi G., Monducci R., Sbardella A., Virgillito M.E. (2023). "From organizational capabilities to corporate performances: at the roots of productivity slowdown". *Industrial and Corporate Change*. (DOI: 10.1093/icc/dtad030).
- Craig S., Kenney A., Lin J., Paul I., Birch L., Savage J., Marini M., Chiaromonte F., Reimherr M., Makova K. (2023). "Constructing a polygenic risk score for childhood obesity using functional data analysis". *Econometrics and Statistics*. (DOI: 10.1016/j.ecosta.2021.10.014)
- Cremona M.A., Chiaromonte F. (2023). "Probabilistic K-means with Local Alignment for Clustering and Motif Discovery in Functional Data". *Journal of Computational and Graphical Statistics*. (DOI: 10.1080/10618600.2022.2156522).
- Cucino V., Marullo C., Annunziata E., Piccaluga A. (2023). "The human side of entrepreneurship: an empirical investigation of relationally embedded ties with stakeholders". *Management Research Review*. (DOI: 10.1108/MRR-08-2022-0593).
- De Paolis R. (2023). "Dalla crisi ideologica della pena detentiva alle prospettive pratiche della giustizia riparativa: il panorama italiano". *Cammino Diritto*, 8/2023.
<https://rivista.camminodiritto.it/articolo.asp?id=9686>.
- De Paolis R. (2023). "The New European Public Prosecutor's Office and The Rule of Law: The Case of Corruption". *Católica Law Review*. (DOI: 10.34632/catolicalawreview.2023.16004).
- De Rosis S., Loppreite M., Puliga M., Vainieri M. (2023). "Analyzing the emotional impact of COVID-19 with Twitter data: Lessons from a B-VAR analysis on Italy". *Socio-Economic Planning Sciences* (DOI: 10.1016/j.seps.2023.101610).
- Dosi G., Lamperti F., Mazzucato M., Napoletano M., Roventini, A. (2023). "Mission-oriented policies and the "Entrepreneurial State" at work: An agent-based exploration". *Journal of Economic Dynamics and Control*. (DOI: 10.1016/j.jedc.2023.104650).
- Dosi G., Marengo L., Staccioli J., Virgillito M.E. (2023). "Big pharma and monopoly capitalism: a long-term view". *Structural Change and Economic Dynamics*. (DOI: 10.1016/j.strueco.2023.01.004).
- Dosi G., Palagi E., Roventini A., Russo E. (2023). "Do Patents Really Foster Innovation in the Pharmaceutical Sector? Results from an Evolutionary, Agent-Based Model". *Journal of Economic Behavior & Organization*. (DOI: 10.1016/j.jebo.2023.05.039).
- Dosi G., Virgillito M.E., Yu X. (2023). "Gains from trade or from catching-up? Value creation and distribution in the era of China's WTO accession". *Eurasian Business Review*. (DOI: 10.1007/s40821-022-00212-5).



- Fagiolo G., Luzzati D.S. (2023). "Centrality in the macroeconomic multi-network explains the spatiotemporal distribution of country per-capita income". *Applied Network Science*. (DOI: 10.1007/s41109-023-00584-1).
- Ferrari, A., Giannini, A., Seghieri, C., Simoncini, T., Vainieri, M. (2023) "Regional practice variation in pelvic organ prolapse surgery in Tuscany, Italy: a retrospective cohort study on administrative health data". *BMJ Open*. (DOI: 10.1136/bmjopen-2022-068145).
- Ferrari A., Seghieri C., Giannini A., Mannella P., Simoncini T., Vainieri, M. (2023). "Driving time drives the hospital choice: choice models for pelvic organ prolapse surgery in Italy". *European Journal of Health Economics*. (DOI: 10.1007/s10198-022-01563-6).
- Ferré F., Seghieri C., Nuti S. (2023). "Women's choices of hospital for breast cancer surgery in Italy: Quality and equity implications". *Health Policy* (DOI: 10.1016/j.healthpol.2023.104781)
- Ferrigno G., Crupi A., Di Minin A., Ritala P. (2023). "50+ years of R&D Management: a retrospective synthesis and new research trajectories". *R&D Management*. 53(5), 900-926. (DOI:10.1111/radm.12592).
- Ferrigno G., Del Sarto N., Piccaluga A., Baroncelli A. (2023). "Industry 4.0 base technologies and business models: a bibliometric analysis". *European Journal of Innovation Management*. 26(7), 502-526. (DOI:10.1108/EJIM-02-2023-0107).
- Ferrigno G., Di Paola N., Oguntegbe K. F., Kraus S. (2023). "Value creation in the metaverse age: a thematic analysis of press releases". *International Journal of Entrepreneurial Behavior & Research*. 29(11), 337-363. (DOI: 10.1108/IJEER-01-2023-0039).
- Fiorinelli G. (2023) "Il concorrente virtuale: la prevenzione dell'uso di ChatGPT per finalità criminali tra etero- e auto- regolazione". *Rivista Italiana di Medicina Legale e del Diritto in campo sanitario*. 2, 361-378. (<https://hdl.handle.net/11382/561152>).
- Gionfriddo, G., Rizzi, f., Daddi, T., Iraldo, F. (2023). "The impact of green marketing on collective behaviour: Experimental evidence from the sports industry". *Business Strategy and The Environment*. (DOI: 10.1002/bse.3420).
- Guzzardi D., Palagi E., Roventini A., Santoro A. (2023). "Reconstructing Income Inequality in Italy: New Evidence and Tax System Implications from Distributional National Accounts". *Journal of the European Economic Association*. (DOI: 10.1093/jeea/jvad073).
- Magazzini L., Calzolari G. (2023). "A LM test for the mean stationarity assumption in dynamic panel data models". *The Stata Journal*. (DOI: 10.1177/1536867X231175).
- Morgante G. (2023). "Individuazione di standard di prevenzione del rischio e regole di compliance nel giudizio su d. lgs. 231/2001", p.1-55 in Centonze, Manacorda (eds) *Verso una riforma della responsabilità da reato degli enti: dato empirico e dimensione applicative*, Milano.
- Palagi E., Napoletano M., Roventini A., Gaffard J. L. (2023). "An agent-based model of trickle-up growth and income inequality". *Economic Modelling*. (DOI: 10.1016/j.econmod.2023.106535).
- Pallante G., Russo E., Roventini A. (2023). "Does Public R&D Funding Crowd-In Private R&D Investment? Evidence from Military R&D Expenditures for US states". *Research Policy*. (DOI:c10.1016/j.respol.2023.104807).
- Seghieri C., Ferré F., Foresi E., Borghini A. (2023) "Healthcare costs of diabetic foot disease in Italy: estimates for event and state costs". *European Journal of Health Economics* (2). (DOI: 10.1007/s10198-022-01462-w)



- Sganga C. (2023). "Dall'armonizzazione alla frammentazione: obiettivi e fallimenti della Direttiva Copyright (2019/790/UE) in materia di ricerca, educazione e accesso al patrimonio culturale". *Rivista di Informatica e Diritto* vol.1, 1-20. (DOI: 10.32091/RIID0095).
- Sganga C. (2023). "Is there still a policy agenda for EU copyright law?". *International Review of Intellectual Property and Competition Law* vol.55, 1407-1417. (DOI:10.1007/s40319-023-01365-0D).
- Sganga C. (2023). "Limiti e limitazioni al diritto d'autore nel nuovo EU Data Package: alla ricerca del sistema perduto". *Annali Italiani del Diritto d'Autore* XXXII, 259-319.
- Sganga C. (2023). "Sui generis protection of non-creative databases", in Bonadio, Goold (eds), "*The Cambridge Handbook of Investment-based Intellectual Property*". Cambridge University Press, 27-53.
- Tagliatela J., Miroshnychenko I., Barontini R., Testa F. (2023). "Talk or walk? The board of directors and firm environmental strategies". *Business Strategy and the Environment*. (DOI: 10.1002/bse.3628).
- Tagliatela J., Pirazzi Maffiola K., Barontini R., Testa F. (2023). "Board of Directors' characteristics and environmental SDGs adoption: an international study". *Corporate Social Responsibility and Environmental Management* 30(5), 2490-2506. (DOI: 10.1002/csr.2499).
- Todaro N.M., Gusmerotti N.M., Daddi T., Frey M. (2023). Do environmental attitudes affect public acceptance of key enabling technologies? Assessing the influence of environmental awareness and trust on public perceptions about nanotechnology. *Journal of Cleaner Production*. (DOI: 10.1016/j.jclepro.2023.135964).
- Wang S. Y., Cantarelli P., Groene O., Stargardt T., & Belle' N. (2023). "Patient expectations do matter- Experimental evidence on antibiotic prescribing decisions among hospital-based physicians". *Health Policy* 128, 11-17. (DOI: 10.1016/j.healthpol.2022.11.009).

TALKS AT CONFERENCES AND WORKSHOPS

Faculty, researchers and students belonging to the L'EMbeDS community presented their work at several important national and international Universities, Conferences and Workshops in 2023. Here we report a selection of the most relevant and prestigious (presenter in bold) in alphabetical order of the speaker's last name:

- EURAM (European Academy of Management) Conference 2023, Dublin. **Alosi A.**, Casamento G., Annunziata E., Rizzi F., Frey M. "The role of self-efficacy in the acceptance of paradoxical tensions at the individual level: linking Paradox and Goal Setting theories".
- Digital Vulnerability in European Private Law, Ferrara. **Amram D.**, "Vulnerabilities in the Digital Environment: New Lenses to Interpret the EU Data Strategy Initiatives". Forthcoming in C.Crea -A. De Franceschi, Nomos, 2024.
- SIMA Conference. Ferrigno G., **Baroncelli A.** "Old wine in new bottles? The challenges and opportunities of the metaverse". <https://www.sijmsima.it/wp-content/uploads/2023/06/Sinergie-SIMA-Conference-Programme-2023.pdf> .
- 64th Annual Conference of the Italian Economic Association (SIE), L'Aquila IT. **Biggi G.**, Mina A., Tamagni F., "There are different shades of green: Heterogeneous environmental innovations and their effects on firm performance", <https://www.lem.sssup.it/WPLem/files/2023-42.pdf>.
- DRUID Conference 2023, Lisbon PT. **G. Biggi**, "Risk, Precaution, and Regulation in Chemical Search and Innovation: The Case of the EU REACH Legislation". <https://www.lem.sssup.it/WPLem/files/2023-06.pdf>.



- 9th European Conference on Corporate R&D and Innovation CONCORDi 2023, Seville (ES). **Biggi G.**, Mina A., Tamagni F., "There are different shades of green: Heterogeneous environmental innovations and their effects on firm performance". <https://www.lem.sssup.it/WPLem/files/2023-42.pdf>.
- Statistics Public Lecture Series - Penn State University, University Park (PA) USA. **Chiaromonte F.**, "What can shapes teach us? leveraging functional data in biomedical applications".
- 17th International Conference on Computational and Financial Econometrics (CFE), Berlin DE. **Coronese M.**, Crippa F., Lamperti F., Chiaromonte F., Roventini A. "Raided by the storm: how three decades of thunderstorms shaped U.S. incomes and wages".
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4628168.
- 28th Conference European Association of Environmental and Resource Economists (EAERE), Limassol CY. **Coronese M.**, Crippa F., Lamperti F., Chiaromonte F., Roventini A. "Raided by the storm: how three decades of thunderstorms shaped U.S. incomes and wages".
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4628168.
- 29th International Conference Computing in Economics and Finance (CEF), Nice FR. Pangallo M., **Coronese M.**, Lamperti F., Cervone G., Chiaromonte F. "Climate change attitudes in a data-driven Agent-Based model of the housing market".
- Biennial International Conference Criminal Justice and Security in Central and Eastern Europe, Ljubljana. **De Paolis R.**, "Exploiting white-collar criminals' know-how: Towards a new way of punishment".
- Católica Graduate Legal Research Conference, Lisbon. **De Paolis R.**, "The New European Public Prosecutor's Office And The Rule Of Law: The Case of Corruption".
- ECLAN (European Criminal Law Academic Network) Graduate Conference 2023 "The Future of European Criminal Law", Liverpool. **De Paolis R.**, "Sextortion: Open Challenges for The European Union in Harmonizing Substantive Rules on Corruption".
- ICON*S (International Society of Public Law), "Politica e istituzioni tra trasformazioni e riforme", Milano. **De Paolis R.**, Governance globale e sovranità nazionale: il caso della criminalità transnazionale nello spazio globale.
- pan-European conference "Implementing the Istanbul Convention. The role of the educational and academic system", Milano. **De Paolis R.**, "Witnessing Domestic Violence and Child Custody: The Italian Case".
- 2023 Global Marketing Conference, Seoul, Corea del Sud. **De Rosis S.**, Grazzini, Vainieri M., Pennucci F., Aiello – Social Marketing Track "Exploring Patients' Trust during Covid-19 Pandemic".
- 2023 IRSPM Conference, Budapest, Ungheria. Spataro V., **De Rosis S.**, Vainieri M. "Co-production of public services: patients' preferences to co-produce in chronic care".
- ECPR General Conference, Prague, 5 Sept. 2023. **Fiorinelli G.**, "Data-driven anti-corruption compliance in public administration: a perspective from Italy" (SERICS).
- R&D Management Conference, Siviglia. **Ferrigno G.**, Barabuffi S., Marcazzan E., Piccaluga A. "What "v" of the big data influence open innovation? An empirical analysis on italian SMEs",
<https://www.conftool.com/rdmanagement2023/sessions.php>.
- Academy of Management, Boston. **Ferrigno G.**, Piccaluga A. "Industry 4.0 Strategy: State-of-the-art and Future Research Directions", <https://doi.org/10.5465/AMPROC.2023.13969abstract>.
- ECPR General Conference, Prague, 5 Sept. 2023. **Fiorinelli G.**, "Data-driven anti-corruption compliance in public administration: a perspective from Italy" (SERICS).



- "ILPC Annual Conference 2023 - Human in the Machine: Digital Rights and AI, London IALS (online). **G. Fiorinelli**. "Unacceptable risks of AI and the role of criminal law: EU and Council of Europe compared" (SERICS)".
- European Economic Association Annual Congress (EEA-ESEM 2023), Barcelona (ES). G. Bottazzi, **Giachini D.**, Ottaviani M., "Market selection and learning under model misspecification", <https://doi.org/10.1016/j.jedc.2023.104739>.
- EURAM (European Academy of Management) Conference 2023, Dublin, "Enablers of sustainability integration in the European sports sector: an empirical investigation through the lens of structuration theory.": Todaro N. M., **Gionfriddo G.**, Daddi T.
- Munich Summer Institute 2023, Munich DE. **Iori M.**, Mina A., Santoleri P. "R&D grants and the novelty of innovation".
- NBER Summer Institute 2023 - Science of Science Funding, Boston (MA) USA. **M. Iori**, A. Mina, P. Santoleri, "R&D grants and the novelty of innovation".
- 2023 Wennberg International Collaborative 2023 Fall Meeting, Pisa. Seghieri C., Ferrè F., **Longhi S.**, Nuti S. "Multispecialty physician networks for chronic care: performance and cost assessment using data from Tuscany".
- Tenth Italian Congress of Econometrics and Empirical Economics, Cagliari IT. Amoroso S., Bruno R. L., **Magazzini L.**, "Exploring the nexus between appropriability and productivity in highly innovative and globalised companies".
- 10th Italian Congress of Econometrics and Empirical Economics, Cagliari IT. **Martinoli M.**, Di Francesco D., Moneta A., Seri R., "Data-driven Identification and Estimation of DSGE models by non-Gaussianity".
- 17th International Conference on Computational and Financial Econometrics (CFE), HTW Berlin, Berlin DE. **Martinoli M.**, Moneta A., Pallante G., "Calibration and Validation of Macroeconomic Simulation Models by Statistical Causal Search".
- 18th Annual Conference of the European Policy for Intellectual Property Protection (EPIP 2023), Krakow PL. Biggi G., **Mazzei J.**, Martinelli A., Giuliani E. "Are we moving to a less toxic world? How bans on Persistent Organic Pollutants affect firms' inventive strategies", <https://journals.aom.org/doi/10.5465/AMBPP.2020.11567abstract>.
- EURAM (European Academy of Management) Conference 2023, Dublin, "The systemic transition of value chains to the circular economy: a co-created measurement framework to link research and practice" - Gusmerotti N. M., **Mecca D.**, Corsini F., Frey M., Cerrutti C.
- 2nd International Conference on the Science of Science and Innovation, University, Evanston (IL) USA. Iori M., Martinelli A., **Mina A.**, "The direction of technical change in AI and the trajectory effects of government funding", <https://www.lem.sssup.it/WPLem/2021-41.html>.
- INEM(International Network for Economic Method) Conference, Venice IT. **Moneta A.**, "Macroeconomic simulation models and causal inference: the challenge of complexity"
- Internet Festival 2023, Pisa. **Morgante G.**, Fiorinelli G. Panel «Tra fake news e notizie "artificiali". IA generativa, disinformazione, strumenti di contrasto».
- Il contrasto alla corruzione. Le potenzialità degli strumenti di analisi tra disponibilità di fonti di big-data, vincoli di privacy ed esigenze di interoperabilità", **Morgante G.** Pisa 6-7 ottobre 2023
- CESifo Venice Summer Institute, Venice IT. Bisio L., Cuzzola A., Grazi M., **Moschella D.**, "Automation, firm-level employment and industry dynamics: new evidence from Italy".
- OECD workshop on Using microdata for start-up and venture capital analyses, Paris FR. M. Iori, A. Mina, **P. Santoleri**, "R&D grants and the novelty of innovation".



- Expert workshop on “An EU copyright and data legislative framework fit for research: barriers, challenges and potential measures”, European Commission, DG RTD Open Science, Brussels, **Sganga C.**, Invited expert speaker on "Implementation of the EU research exception" (23 February 2023)
- ECS Annual Conference "The interface between copyright and data regulation", Leuven, **Sganga C.**, "The exception for copyright and trade secret to data sharing obligations: current outlook and proposals of reform".
- EPIP 18th Annual Conference 2023 "IP, Innovation and Technology", **Sganga C.**, Signoretta C., "Time for a Fair Use Doctrine for Data in the EU?", Krakow, 12 September 2023.
- Final Conference H2020 project reCreating Europe, **Sganga C.**, organizer, moderator of Day 1 and speaker, "The state of EU copyright flexibilities: comparative mapping" (Day 1); "Three years of reCreating Europe" (Day 2 - "The future of EU copyright law: policy recommendations"), Brussels, 21-22 March 2023.
- UNCTAD Creative Economy Outlook 2024 online scoping meeting, **Sganga C.**, Invited expert speaker, Session 2 “The impact of digital transformation and the use of artificial intelligence on creative industries” (24 May 2023).
- Workshop on "Text and data mining best practices", **Sganga C.**, Institute of Information Law, University of Amsterdam, 27-28 June 2023, invited expert.
- EURAM (European Academy of Management) Conference 2023, Dublin, Gusmerotti N. M., Todaro N. M., **Tosi D.**, Testa F. "Green work climate and employees' eco-initiatives: assessing interactions of work meaningfulness and supervisor environmental propritry".
- 38th Annual ACM/IEEE Symposium on Logic in Computer Science (LICS), Boston (MA) USA. Argyris G., Lluch-Lafuente A., Leguizamon-Robayo A., Tribastone M., Tschaikowski M., **Vandin A.**, "Minimization of Dynamical Systems over Monoids" (Conference ranked A* - top 7% in computer science in the CORE ranking).

6. EDUCATION AND RESEARCH-RELATED ACTIVITIES: INTERNAL AND EXTERNALLY FUNDED PROJECTS

During 2023, members of the L'EMbeDS community continued their work on a variety of projects supported by our High-Performance Computing Infrastructure. The table below provides a snapshot of some such project, organized by the VMs (Virtual Machines) created on our cluster:

VM	Description
IdE (Economics)	Various projects by IdE researchers, among which: analyses of massive patent datasets, Agent Based Model simulations and development of related statistical methods, causal statistics techniques, robust statistics techniques, optimization.
IdM (Management)	Various projects by IdM researchers, among which: analysis of patents related to small and medium-sized firms, text mining, analyses of twitter data related to COVID-19.
Predictive Justice	Various projects within the Predictive Justice umbrella (predictivejustice.eu), including preprocessing of text data from verdicts, their pseudo-anonymization, and their analysis with AI algorithms.
CoMoS Climate Change	Various projects related to climate change and its socio-economic impacts by the young researchers in CoMoS, including large simulations and storage and analyses of massive geo-localized data sets on climate features and economic indicators.



CoMoS Science, Technology and Innovation	Various projects related to science, technology and innovation by the young researchers in CoMoS, including network-based and statistical analyses of massive bibliometric datasets on scientific publications, patent datasets, etc.
CoMoS Economic Dynamics	Various projects related to economic dynamics by the young researchers in CoMoS, among which: Agent Based Models of macroeconomic phenomena, models of financial markets, models of industrial dynamics, and machine learning approaches for the representation of decision making.
DBMS	SQL Database Management System to support various L'EMbeDS projects
ISV (Life Sciences)	Various projects by ISV researchers, among which analysis of large genomic data on crops and plants under-characterized to date, development of bioinformatics methods.
TALTAC	TalTac project (taltac.com); development and testing of the version 4.0 of the TalTac textmining software
MeS	Various project by researchers of the MeS Laboratory of IdM, among which CoNtAcT (Chronic Network Accountability, Tuscany), studies of the Healthcare system and of patients experience and satisfaction, analysis of large datasets from administrative sources and <i>ad hoc</i> surveys.

Faculty, researchers and students belonging to L'EMbeDS community also continued their work on a variety of externally funded projects. We report below a selection of those which we consider of high potential impact for the research areas covered by L'EMbeDS.

Among the projects awarded or beginning in 2023:

- AISLA2: Artificial Intelligence & Statistical Learning for Energy-Aware Extreme Automation (Bando Assegni di ricerca 2023, 50% Regione Toscana, 50% Tuscany company), 2 years. PI: A. Vandin. Climate change and the energy and raw material crisis are increasingly impacting industry, especially energy-intensive sectors such as the paper industry. The green transition of these sectors needs to be fostered with AI. AISLA2 will develop a methodology from data collected by Extreme Automation and A.Celli Group, a leader in paper machines and TNT, for the parameterization of complex industrial processes. It will develop statistical learning techniques to support decisions and justify them (explainable AI).
- CURA: Children as vulnerable users of IoT and AI-based technologies; a multi-level interdisciplinary assessment. MUR PRIN 2022, 2023-2025. Project Coordinator: D. Amram. CURA aims to develop new knowledge and share awareness to protect, promote and implement children's fundamental rights in the digital environment.
- FIND: Finance and Innovation to couple Negative Emission technologies and sustainable Development. ERC StG, 2023-2028. PI: F. Lamperti. The FIND project aims to evaluate the feasibility and desirability of limiting global warming through negative emission technologies. Current climate efforts are insufficient, and achieving the goals of the Paris Agreement may require carbon removal methods. However, these technologies are currently immature and risky. FIND seeks to understand their diffusion potential, socioeconomic impacts, and how to finance them effectively – integrating disciplines like climate science, economics, and innovation studies to provide breakthrough evidence on carbon removal solutions. The project aims to create robust policy portfolios for achieving a net-zero society, aligning with Europe's commitment to carbon neutrality by 2050. <https://cordis.europa.eu/project/id/101117427>.
- OPENMUSE: Horizon Europe (European Commission), 2023-2025. Unit leaders at SSSA: C. Sganga, A. Martinelli. OpenMusE brings together music industry stakeholders and researchers from 11 EU countries



and Ukraine. Our consortium recognizes that placing European music ecosystems on a more competitive, fair and sustainable footing requires evidence-based policymaking, business planning, and accuracy. We provide the data needed for these actions. Using transparent methods and tools, OpenMusE maps the policy and data landscape, bridges data gaps and empowers stakeholders and policymakers to take data-driven actions. <https://www.openmuse.eu/>.

- CYBERRIGHTS: PNRR PE7 Partenariato esteso in Cybersecurity SERICS, 2023-2025. Spoke 1. WP4 leader at SSSA: G. Morgante. CybeRights aims to establish a new integrated, holistic, multidisciplinary and problem-solving idea of cybersecurity. WP4 will analyze, from the point of view of both substantive and procedural criminal law, criminology and international law, different models of prevention and repression of Cyber Crimes committed against individuals, corporations, public bodies and critical infrastructures as a regulatory tool to protect the cyberspace, also in light of the relevant international obligations and paradigms of international cooperation (Cyber Diplomacy). <https://serics.eu/services/spoke-1-asperti-umani-sociali-legali/>.
- BORDERLINE: MUR PRIN 2022, 2023-2025. PI: G. Morgante. The project concerns the hybridization of the fight against crime through non-criminal or BORDERLINE measures: principles, rules, limits and opportunities for an integrated system.
- Data Driven Innovation: Measuring Effects on Industries, Firms, and Business Model. MUR PRIN 2022, 2023-2025. Unit leader at SSSA: F. Tamagni. This project examines the fundamental relations between Data-Driven Innovation (DDI) and its effects on the structure and dynamics of industries (structural change, entry/exit/survival), firm performance (productivity, growth, innovation) and business models. By integrating different research streams in innovation, entrepreneurship, management, industrial dynamics and data-science, the project provides an empirical mapping of DDI processes, exploring new ways of measuring DDI via machine-learning and non-conventional sources.
- NEWS: SteeriNg financE toWards green technologieS: a hybrid experimental-computational macro approach. MUR PRIN 2022, 2023-2025. PI: F. Lamperti. The project aims to address the challenge of reducing carbon emissions to limit global warming to 1.5°C above pre-industrial levels by studying factors influencing investor expectations in the green transition. It focuses on the need for long-term financing for developing and disseminating climate technologies. By examining behavioral and institutional factors, the project seeks to understand how public policies can encourage investment in green technologies.
- ALMONDO: Analyzing climate Lobbying with a simulation Model based ON Dynamic Opinions. MUR PRIN 2022, 2023-2025. PI: D. Giachini. This project proposes a novel modeling framework to study climate lobbying that carefully considers features of human learning and communication, is grounded in empirical observations, allows for scenario analysis, improves policy design, and is embedded in ready-to-use, user-friendly computational tools. The project mixes knowledge, models and methods from economics and computer science to overcome limitations of current approaches. <https://prin.mur.gov.it/Iniziativa/Detail?key=xntlwCEQ%2BTLxeoukrh%2FdQ%3D%3D>.
- Automation, Trade, and Global Value Chains: New Empirical Evidence and Theory Development. MUR PRIN 2022, 2023-2025. PI: D. Moschella. This project investigates the interplay between automation, digitalization, and globalization, and their impact on socio-economic systems. It explores how the adoption and diffusion of new technologies across sectors and countries may affect innovation, competitiveness, and the organization of production processes, while also considering the potential consequences for workers and firms in terms of wage structure and market participation.



<https://prin.mur.gov.it/Iniziativa/Detail?key=FiJNdaCuA71Xq3jYMAuZeQ%3D%3D>.

- MALERP: Market Learning and Robust Predictions. MUR PRIN 2022, 2023-2025. Unit leader at SSSA: D. Giachini. The goal of this project is to propose a new aggregation mechanism called "Generalized Market Predictions" (GMP) that improves upon alternative ways to harness the WOC. GMP is inspired by the literature on Financial Economics, General Equilibrium, Computer Science, and Experimental Economics. It is a flexible theory for aggregating agents' opinions in a consensus which is reliable and efficient. <https://prin.mur.gov.it/Iniziativa/Detail?key=FiJNdaCuA71Xq3jYMAuZeQ%3D%3D>.
- REBOOT: Horizon Europe (European Commission) 2023-2025. Unit leaders at SSSA: C. Sganga, A. Martinelli. The European film industry is the third largest in the world and worth more than EUR 120 billion. REBOOT will study the European film industry, identify weaknesses and ways to overcome them, connect existing strengths and plan for future competitiveness. Looking to the future, it will explore audience preferences and their generation, as well as modes of film content production. The project will study how to increase young people's engagement with European film, boost the EU's position in the global film industry and support cultural diversity in the EU film industry. <https://thereboot-project.eu/>.
- SMAUG: Smart Maritime and Underwater Guardian Grant Agreement n. 101121129 HORIZON-CL3-2022-BM-01 2023-2026. PI DIRPOLIS Unit: D. Amram. SMAUG aims to improve the underwater detection of threats in ports and their entrance routes, by means of an integrated system capable of providing data concerning threat analysis between 3 main elements: ports security infrastructure, advanced underwater detection systems and surveillance vessels.
- Tender, European Commission – DG RTD Open Science, 2023-2024 (Contract No. RTD/2023/SC/01). Preparation of a "Study to evaluate the effects of the EU copyright framework on research and the effects of potential interventions, and to identify and present relevant provisions for research in EU data and digital legislation, with a focus on rights and obligations". Unit leader at SSSA: C. Sganga.
- Toxicity of Patented Chemical Compounds and The Dark Side of Innovation. DFG (Deutsche Forschungsgemeinschaft), 2023-2024. Unit leader at SSSA: A. Martinelli. The project focuses on measuring "patent toxicity", that is, the extent to which a patent includes compounds that are toxic to humans and/or the environment. A patent toxicity index will be constructed to investigate the "dark side" of innovation. Our novel patent toxicity indicator will allow us to study how the emergence of hazardous innovations relates to observable determinants, including market structure, regulatory intervention, and government incentives.

Among the ongoing projects:

- ALCHIMIA (European Commission), 2022-2025. Unit leader at SSSA: F. Iraldo. The project aims at building a platform based on Federated Learning and Continual Learning to help big European metallurgy industries unlock the full potential of Artificial Intelligence to support the needed transformations to create high-quality, competitive, efficient and green production processes. ALCHIMIA will find an optimal mix to reduce energy consumption, emissions and waste generation of the steelmaking process, while also guaranteeing to obtain high-quality products. SSSA develops the project through an inter-institute collaboration (TeCIP Institute and IdM).
- CERV-2021-DAPHNE (European Commission) ENGINE (Engaging Men and Boys against Gender-based Violence and Discrimination through Technology-based Trainings), 2022-2023. Unit leader at SSSA: A. Loretoni; WP leader: G. Morgante. The project designs and implements dedicated trainings to raise



awareness on and combat Gender-based Violence and Discrimination, working on models of masculinities and training men and boys as allies. The trainings are designed by a multidisciplinary committee of scholars and experts in social and applied sciences and will also employ immersive virtual reality technologies. <https://www.santannapisa.it/it/istituto/dirpolis/engine-project>

- CO2PES&PEF LIFE (European Commission), 2020 - 2023. Unit leader: F. Iraldo. The project will conduct an analysis of the ecosystem services of three forest areas, representative of the Alpine and Apennine areas, and their operational implementation in order to: 1) evaluate the contribution of sustainable forest management, conservation and growth of carbon fixation and storage capacity and of other ecosystem services; 2) Define certification registers for ecosystem services, following an analysis of scientific literature and existing experiences; 3) Provide an evaluation economics for ecosystem services deriving from sustainable forest management, which can be used to create a system of "ecosystem credits"; 4) Create a model for the development of a register and a market of ecosystem credits, with the possibility of including them in the " green bonds ", in line with the latest plans of the European Community on socially responsible investments. Ecosystem services will be those resulting from sustainable forest management practices. <https://lifeco2pefandpes.eu/en/>.
- CoNtAcT - Accountable networks for chronic populations: new governance mechanisms to promote professional integration and value improvement, 2020-2023. Funded by Tuscany Region (Bando Ricerca Salute 2018). PI: C. Seghieri, Co-PI S. Nuti, in collaboration with the Local Health Units Toscana Centro, Nord-Ovest, Sud-Est, the Teaching Hospitals of Siena, Pisa and Careggi (Firenze) and Fondazione Toscana Gabriele Monasterio of Pisa. The principal aim of the project is to develop and validate alternative governance mechanisms to organize, evaluate and allocate resources for the care of chronic patients. This is intended to promote the integration and sharing of responsibilities among professionals (e.g., primary care and specialists) and increase value for patients and the system.
- CORALIS H2020 (European Commission), 2020-2024. Unit leaders: M. Frey, E. Annunziata. The project envisages the development of actions to favor the decarbonization of energy-resource intensive industrial sectors through industrial symbiosis approaches that integrate technological solutions with new business and managerial strategies. Applications will involve three industrial areas in Italy, Spain and Sweden, and the implemented approaches will be shared with other European industrial areas (in Spain, Austria, Poland and Turkey). The economic, environmental and managerial effectiveness of the implemented solutions will be assessed, and a strategy will be structured for the replicability of industrial symbiosis initiatives in other contexts. <https://www.coralis-h2020.eu/>.
- Data-driven Elicitation, Explanation, and Enhancement of Healthcare systems. PRO3, 2022-2024. PI: C. Seghieri, Co-PI: A. Vandin. The project will develop and apply data-driven analysis techniques for monitoring the efficiency of health systems, including explainable AI, process mining techniques, process- and network-oriented analysis for complex systems.
- DigiCare4You: An intersectoral innovative solution involving DIGItal tools, empowering families and integrating community CARE services for the prevention and management of type 2 diabetes and hypertension (European Commission), 2021-2025. Unit leader at SSSA: C. Seghieri. The project will develop, implement and evaluate organizational, technological and public health innovations aiming to empower families and integrate community care services in Europe for the prevention and management of type 2 diabetes and/or hypertension.



- EEIST: Economics of Energy Innovation and System Transition, 2020-2023. The project is sponsored by the UK Department for Business, Energy and Industrial Strategy (BEIS) and the Children's Investment Fund Foundation (CIFF). Unit leader and coordinator: A. Roventini. <https://eeist.co.uk>.
- EINST4INE. WP1 unit Leader at SSSA: A. Di Minin. European Training Network for Industry Digital Transformation across Innovation Ecosystem. The project is funded by the Marie Skłodowska-Curie European Training Networks programme (Grant agreement n. 956745). The project offers a program with a wide range of multidisciplinary research and practical training combined with workshops, summer schools and one-off international, interdisciplinary mobility and secondment opportunities in Europe, the USA and Australia. The consortium consists of a unique group of world-leading experts in Industry 4.0, digital transformation and innovation ecosystems, combined with established doctoral training programs and support structures. <https://www.einst4ine.eu/>.
- FEAST: Horizon Europe (European Commission), 2022-2027. WP2 unit Leader at SSSA: A.M. Murante. The project promotes strategies and policy towards healthy diet behaviors, mainly among vulnerable people; SSSA is in charge of mapping food purchasing and consumption behaviors by means of a cross-sectional survey across 27 European countries, and support the intervention of the Italian Living Lab. <https://feast2030.eu/>.
- PaRIS: Patient-Reported Indicator Surveys, 2020-2023. Unit leaders at SSSA: S. Nuti, M. Vainieri. The PaRIS initiative aims at collecting, comparing and sharing information on primary care provided to patients with chronic diseases, in order to support countries in improving care services. In Italy, the goal is to develop an observatory to systematically collect data on patient outcomes and experiences with primary care, to improve the effectiveness and efficiency of health systems based on patient reported evaluations. This project is part of the activities implemented by the Ministry of Health to measure and increase the value produced in healthcare and make the system more person-centered. <https://www.oecd.org/health/paris/>; <https://www.santannapisa.it/it/ricerca/progetti/osservatoriopremscronici-paris>.
- Regions4Climate: Regions for Climate (European Commission), 2022-2027. Unit Leader at SSSA: M. Frey. Project partners commit to address current and forecasted climate change-related challenges and build more resilient European communities within an innovative, socially engaged, citizen-driven paradigm. The project aims to develop smarter, more inclusive, more resilient regional ecosystems through cross-sectoral innovation jointly created with stakeholders, by and for the people. New scientific insights, along with a framework of interoperable tools, methodologies and demonstrated solutions will enable European regions to develop their own resilience plans and transformative adaptation pathways.
- SoBigData RI PPP (European Commission), 2021-2025. Unit leader at SSSA: A. Piccaluga. The SoBigData RI Preparation Phase Project (PPP) is the preparatory phase of the SoBigData RI in the ESFRI RoadMap 2021. SoBigData RI PPP will advance the RI from simple awareness of ethical and legal challenges in social mining to the development of concrete tools that operationalize ethics with value-sensitive design, incorporating values and standards for privacy protection, fairness, transparency, and pluralism. <https://ppp.sobigdata.eu>.
- SoBigData++ H2020 (European Commission), 2020-2024. Unit leader at SSSA: A. Piccaluga. SoBigData++ strives to deliver a distributed, Pan-European, multi-disciplinary research infrastructure for big social data analytics, coupled with the consolidation of a cross-disciplinary European research community, aimed at



using social mining and big data to understand the complexity of our contemporary, globally-interconnected society. <https://plusplus.sobigdata.eu/>.

- TRICK H2020 (European Commission), 2021-2024. Unit leader at SSSA: F. Testa. The textile industry is widely criticized for its impact on the environment. It has become a major driver of climate change and needs a circular makeover. However, the adoption of sustainable and circular approaches in all business sectors hinges on the availability of product data. Traceability relies on the access to reliable data. In this context, TRICK will provide a platform that will enable enterprises to collect product data. For instance, data extracted by the fiscal documents for the preferential certification of origin will be integrated with the bill of materials, saved in the Blockchains for each production lot. TRICK will run pilot demonstrations in the textile-clothing industry and the perishable food industry for replication. <https://www.trick-project.eu/about>.

7. EDUCATION AND RESEARCH-RELATED ACTIVITIES: AFFILIATIONS

Throughout 2023, L'EMbeDS continued to pursue strategic affiliations of faculty and researchers both within and outside of SSSA. In particular, we affiliated four additional members of the Sant'Anna School (<https://www.santannapisa.it/it/news/we-welcome-robel-takele-jemal-seid-ahmed-svenja-mager-and-leonardo-caproni-center-plant>), Drs. Takele, Ahmed, Mager, Caproni of the Plant Sciences Research Center. These affiliations strengthen the collaborations between the Center and L'EMbeDS in research relating to climate change and its impacts. Furthermore, we granted a junior affiliation to Dr. Testa (<https://www.santannapisa.it/it/news/we-welcome-dr-lorenzo-testa-lembeds-affiliate>), a graduate of Sant'Anna and current doctoral student in the Statistics and Data Science program of the Carnegie Mellon University of Pittsburgh, who contributes to numerous projects involving L'EMbeDS faculty and researchers.

8. EDUCATION AND RESEARCH-RELATED ACTIVITIES: NEW COURSES

During 2023, we spearheaded the creation of a new Level II (Master's) Diploma in Data Science at the Sant'Anna School, with a corresponding Area; see <https://www.santannapisa.it/it/dipartimenti-eccellenza/embeds/II-Level-Honour-Course-in-Data-Science>. The working group appointed by the School to plan and establish the new diploma comprises Prof. Laura Magazzini (Econometrics), Prof. Chiara Seghieri (Social Statistics) and Prof. Andrea Vandin (Informatics), three recruits from the first cycle of the Department of Excellence, together with Prof. Francesca Chiaromonte, the Scientific Coordinator of L'EMbeDS. This important development will require a further expansion of the innovative cluster of coordinated courses developed by L'EMbeDS members in recent years – whose most recent version (a.y. 2023-24) can be found at <https://github.com/EMbeDS-education/ComputingDataAnalysisModeling20232024/wiki>.

Leveraging such courses and the research trajectories generated by the L'EMbeDS community, the new Level II Diploma will start in the 2024-25 academic year. Honors student pursuing the new Diploma will concurrently enroll in one of two Master of Science degrees (Laurea Magistrale; LM); namely:

- the LM in Data Science and Business Informatics (LM-18 Computer Science / LM-DATA Data Science) offered by the University of Pisa, which has been available to Sant'Anna Allievi since 2018. This LM provides students with interdisciplinary skills in Data Science, Computing and Statistics, and a focus on applications in the business domain. Graduates of the LM have excellent placement in the private



sector, as well as in research organizations and doctoral programs. Among the Sant'Anna Allievi who already graduated from this LM we find: Christian Esposito (graduated in 2020), now a data scientist working on machine learning applied to healthcare and biomedical research at Owkin in Paris (France), Lorenzo Testa (graduated in 2022), now a PhD student in the Statistics & Data Science program at Carnegie Mellon University in Pittsburgh (PA, USA) and a junior affiliate of L'EMbeDS, and Filippo Michelis (graduated in 2023), who will start a PhD in Statistics in the US in the Fall of 2024.

- the LM in Statistics and Data Science (LM-82 Statistics) offered by the University of Florence which has just been made available to Sant'Anna Allievi starting with the 2024-25 academic year. This LM introduces students to foundational methodology in Statistics, Mathematics, Probability and Computing – and to application domains including socio-demographic, economic, biomedical, and environmental research. Students acquire the skills necessary to analyze complex data using modern statistical methods, and play a pivotal role in large corporations, consulting firms, or research institutions.

As the new Area and II level Diploma will become established at the Sant'Anna School, L'EMbeDS faculty and researchers will work to expand training and research opportunities for the students, strengthening coordination and synergies with the faculty of the LM programs at the Universities of Pisa and Florence.

<https://www.santannapisa.it/it/dipartimenti-eccellenza/embeds/II-Level-Honour-Course-in-Data-Science>.

9. INTERACTIONS AND AGREEMENTS WITH INSTITUTIONAL AND PRIVATE SECTOR PARTNERS

Regarding interactions with stakeholders (institutional and private sector) and our role in the Data Science and Artificial Intelligence community (local, national and international), during 2023 L'EMbeDS has further strengthened its collaboration with the CBDAl – a Regional center composed of various institutions, aimed at creating a permanent Research Infrastructure on the topic of Big Data and Artificial Intelligence, for the benefit of companies (of all sizes), public administrations, academic units and researchers in Tuscany – as well as representing a point of reference and aggregation at the national and international level. Also relevant is the collaboration between L'EMbeDS and the extended FAIR partnership established in 2022 through PNRR funds.

We work closely with FAIR's Spoke 1, focused on Human Centered AI, which connects most actors of the Pisan/Tuscan academic community dedicated to Data Science (https://pnrr.unipi.it/wp-content/uploads/2024/05/DR_Approvazione-Atti_BaC_FAIR.pdf). This culminated with our application to one of the cascade funding calls opened by FAIR at the beginning of 2024. Several L'EMbeDS members are also key contributors to the European network EELISA (European Engineering Learning Innovation and Science Alliance), aimed at defining pilot projects to foster the hybridization of engineering education with non-STEM skills and competences, and vice versa, of non-engineering professions with increasingly required STEM knowledge.

Our ties with research groups outside Sant'Anna include the Quantitative Finance Group (Scuola Normale Superiore, Pisa) and the KDD lab (CNR and University of Pisa). We are also members of the AI and Data Science Hub for Humans and Society - which coordinates research groups in CNR, UniPi, Sant'Anna, SNS and IMT, and of the Center for Big Data and AI (CBDAl) - a regional Center on Big Data, Data Science and AI which, in addition to those Pisan institutions, includes the Universities of Firenze and Siena.



Within such Institutes, our mission is especially aligned - and our activities intertwined - with those, e.g., of CoMoS (Complexity Modelers' Society) and its CoMoS Climate Change (CCC), Science, Technology and Innovation (CSTI), and Economic Dynamics (CED) projects, the MeS lab (Management e Sanita'), the LIDER lab (Laboratorio Interdisciplinare Diritti e Regole) and its Predictive Justice project, and NESCI (Network for Statistical and Causal Inference).

Various Sant'Anna faculty and researchers who belong to the Class of Experimental Sciences of Sant'Anna have also become official affiliates of EMbeDS, including Tommaso Cucinotta, Roberto Buizza, Enrico Pe', Matteo Dell'Acqua and Carlo Alberto Avizzano. Faculty and researchers outside the School have also become affiliates, including Caterina Giannetti (University of Pisa), Sergio Bolasco (Università di Roma La Sapienza), Giovanni De Gasperis (Università degli Studi Dell'Aquila), Guido Cervone (Penn State University), Marco Tedesco (Columbia University) and Marco Pangallo (CENTAI Institute, Torino).

11. INFRASTRUCTURE: DATA BASE AND SOFTWARE ACQUISITION

In continuity with the first cycle, L'EMbeDS foresees significant investments in DATABASES AND SOFTWARE LICENSES. During 2023 we renewed 3 access licenses already acquired in previous years, the continuous use of which is crucial for the advancement of numerous research projects. These concern:

- PROPRIETARY DATA on companies and patents with ORBIS (data on over 280 million companies) and ZEPHYR (data on M&A, IPO, private equity and venture capital transactions). Renewed in March 2023 (€ 50.000,00)
- PROPRIETARY DATA on energy sector sources with ENERDATA, Power Plant Tracker. Renewed in October 2023 (€ 7.320,00)
- QUALTRICS license (online survey development). Renewed in December 2023 (13.450,50 €)

The planned COMPUTATIONAL INFRASTRUCTURE expansion (on MUR budget) and the realization of an improved, state-of-the-art machine room to safely host the expanded infrastructure (part of the SSSA funding commitment to the Department of Excellence) will take place starting in 2024 and likely extending onto 2025.

12. RECRUITMENT: ACHIEVEMENTS IN 2023 AND PROGRESS IN EARLY 2024

During 2023, we spearheaded an innovative Call for Expressions of Interest (CEI) for the recruitment of the four RTT (tenure track assistant professor) positions comprised in the L'EMbeDS proposal. The CEI solicited information from potential candidates through CVs, statements of interest and a self-assessment questionnaire, seeking simultaneously economic, managerial, legal and methodological profiles. We screened expressions of interest through multiple cut-off points over the course of a full year, evaluating them relative to the needs of the different research areas characterizing our departmental project, mission and evolving activities (<https://www.santannapisa.it/it/news/call-expressions-interest-four-tenure-track-assistant-professors-department-excellence-lembeds>).

The CEI led to the recruitment of a first RTT in Social Statistics (SC 13D3, SECS-S05), Dr. Valentina Lorenzoni, who joined L'EMbeDS and the Institute of Management of the Sant'Anna School at the end of 2023; see <https://www.santannapisa.it/it/news/valentina-lorenzoni-joins-lembeds-tenure-track-researcher-rtt-social-statistics>. In the first months of 2024 we also made substantial progress towards the recruitment of a second



[RTT, which will likely occur in 2024 through the direct call \(“chiamata diretta”\) of a researcher currently employed abroad.](#)

Overall, the CEI received great interest and generated impressive results. At the final closing date (20 March 2024) the overall participation amounted to 89 researchers, distributed across all the required profiles and came from around 68 Universities or Research Centers European and international.

Finally, in the first months of 2024 we published a mobility notice for the call of a full professor in Informatics (Area 01), pursuant to art. 7, paragraph 5-bis and 5-ter of Law 30 December 2010, n. 240 (<https://www.santannapisa.it/en/selezioni/mobility-notice-full-professor-post-pursuant-art-7-par-5-bis-and-5-ter-law-n-240-december>, <https://www.santannapisa.it/it/news/santanna-school-seeks-leading-figure-data-science-full-professor-position-open>), targeting a high-level senior recruitment that will strengthen the leadership of L'EMbeDS and broaden its scope in the domain of Computer Science, as illustrated in the proposal.

15. MANAGEMENT, MONITORING AND PLANNING ACTIVITIES

Our MANAGING BOARD was formed at the beginning of the first cycle in 2018, and then expanded first in 2022 and then in 2023 - with the beginning of the second cycle of the Department of Excellence. The board currently comprises (in alphabetical order):

- [Nicola Bellè](#) is Associate Professor at the Institute of Management of the Sant'Anna School. His research focuses on behavioral human resource management. Prior to joining the Sant'Anna School, Nicola was an assistant professor at Bocconi University and a faculty member of the SDA Bocconi School of Management, where he used to serve as the managing editor of the Observatory on Change in Public Administration.
- [Francesca Chiaromonte](#) is the **Scientific Coordinator** of L'EMbeDS. At Sant'Anna, she is a Full Professor of Statistics in the Institute of Economics, and the internal referent for the national PhD in AI & Society. She also teaches Statistics and directs the Institute for Genome Sciences (one of the Huck Institutes) at the Pennsylvania State University. She develops methods for the analysis of large, high-dimensional and complex data, and applies such methods in several scientific fields – including contemporary “Omics” sciences, Meteorology and Economics. She holds a PhD in Statistics from the University of Minnesota (USA) and a Laurea in Statistics and Economic Sciences from the University of Rome La Sapienza. She is a Fellow of the American Statistical Association and of the Institute for Mathematical Statistics.
- [Lino Cinquini](#) is Full Professor of Management Accounting and Business Administration and the current Director of the Institute of Management of the Sant'Anna School. Previously he had professorships at the University “Parthenope” of Naples (2001-2004) and at the University of Pisa (1998-2001 as Associate Professor, 1992-1997 as Lecturer and Senior Lecturer). He holds a PhD in in Economia Aziendale (Business Administration) from the University of Pisa in 1990.
- [Giovanni Comandè](#) is Full Professor of Private Comparative Law at the DIRPOLIS Institute of the Sant'Anna School, and is the founder and Director of the LIDER-LAB (www.lider-lab.it). He has broad international experience, directs top ranking law journals, and acts as external scientific evaluator, ethical expert or consultant for the EU Commission and several academic, funding and policy institutions around the world. His research concerns law and technology, data protection and privacy, ethics and legal issues in research, tort law and personal injury damages, comparative law,



European private law, health law and information society law (privacy, e-commerce and algorithm regulation), ADR.

- [Giulio Ferrigno](#) is Assistant Professor at the Institute of Management of the Sant'Anna School. He held visiting positions at University of Cambridge (UK), Tilburg University, and University of Umea. His research concerns the implementation of Industry 4.0 and the use of big data in innovation management. His work highlights best practices, performance analyses, and societal implications of companies adopting these technologies.
- [Francesco Lamperti](#) is Associate Professor at the Institute of Economics of the Sant'Anna School and a Scientist at the RFF-CMCC European Institute of Economics and the Environment (Milan). He also co-leads the Complexity Modelers Society (CoMoS) within L'EMbeDS. His research interests focus on macroeconomics, agent-based and integrated assessment modeling, climate change economics, and the dynamics of natural disasters. Further, he is interested in the assessment of novel low-carbon technologies and their diffusion dynamics. Francesco holds a Bachelor and a Master of Science in Economics from Bocconi University (Milan) and, in 2016, he obtained a Ph.D. in Economics from the Sant'Anna.
- [Alessia Macchia](#) is the Director General of the Sant'Anna School. She graduated in Business Economics from the University of Pisa and obtained a PhD from Sant'Anna, after which she gained extensive experience in the public administration sector and in HR management. In particular, she served as Administrative Director of the USL 2 Lucca Health Unit (2012-2015) and as Director of Human Resources Management of the USL Toscana Nord Ovest Health Unit, managing over 13,200 employees.
- [Andrea Mina](#) is one of the **Associate Scientific Coordinators** of L'EMbeDS. At the Sant'Anna School he is Full Professor of Economics at the Institute of Economics, as well as the School's Pro-Rector for International Relations. Until October 2016 he was University Lecturer in Economics of Innovation at the Cambridge Judge Business School, of which he is now a Research Fellow. In Cambridge he was also Senior Research Associate of the Centre for Business Research and Director of Economic Studies and Fellow of St Edmund's College.
- [Gaetana Morgante](#) is Full Professor of Criminal Law and the Director of the Dirpolis Institute of the Sant'Anna School. She carries out research activities in Criminal Law focusing on following subject matters within the remit of criminal justice: public and private corruption, criminal labour law, principles of criminal responsibility in risky activities, models of corporate liability, legal tools for fighting illegal markets. She have been also engaged in the analysis of organised crime and terrorism, protection of vulnerable persons and gender-based victimisation. Her research interests as well as her teaching activities over the years have been related to other criminal law topics, such as general theory of the crime, international and European criminal law and justice and criminal law and cultural heritage.
- [Sabina Nuti](#) is Full Professor of Health Management at the Institute of Management of the Sant'Anna School, coordinator of the Management and Health Laboratory (MeS), and the Rector of the School. Her research concerns performance evaluation systems, efficiency and governance mechanism in health care. She coordinates the Inter-regional performance evaluation systems (<http://performance.sssup.it/netval>), has been a member of Expert Panels and Joint Assessment Frameworks for the European Commission, and is a member of the Scientific Committee of the National Outcome Program of the National Italian Agency for Regional Health Services.
- [Alessandro Nuvolari](#) is Full Professor of Economic History and the former Director of the Institute of Economics of the Sant'Anna School. Prior to becoming director, he was the coordinator of the PhD



program in Economics at Sant'Anna. A graduate of Bocconi University with a PhD in Economics from the Eindhoven University of Technology (Netherlands), his research is focused on the role played by science and technology in the emergence and consolidation of economic growth both in historical and contemporary contexts.

- [Andrea Piccaluga](#) is Full Professor of Innovation Management and the former Director of the Institute of Management of the Sant'Anna School. In addition, he is the President of Netval (www.netval.it), the Italian network of University Technology Transfer Offices, and has launched the DBA programs at Sant'Anna (www.dba.idm.sssup.it). He holds a PhD from Sant'Anna and a Master in Technology and Innovation Management from SPRU (University of Sussex, Brighton UK).
- [Andrea Roventini](#) is Full Professor of Political Economy and the current Director of the Institute of Economics of the Sant'Anna School. He was also the coordinator of the European H2020 project "Growth Welfare Innovation Productivity" ([GROWINPRO](#)) and coordinator of the Sant'Anna School of Advanced Studies unit in the Economics of Energy Innovation and System Transition ([EEIST](#)) project. His main research interests include the analysis of complex systems, computational economics based on heterogeneous agents, economic growth, business cycles and crises, innovation and structural change, climate change, and the study of the effects of monetary, fiscal, innovation, industrial and policies to face climate change.
- [Chiara Seghieri](#) is one of the **Associate Scientific Coordinators** of L'EMbeDS. At the Sant'Anna School she is Associate Professor at Institute of Management. She works on a variety of health policy and health care research projects and her current research interests include the use of statistical methods for the measurement and assessment of health care quality and equity using observational data from both sample surveys and administrative records.
- [Caterina Sganga](#) is one of the **Associate Scientific Coordinators** of L'EMbeDS. At Sant'Anna School she is Associate Professor at the the Institute of DIRPOLIS of the. Prior to her appointment at the School, she was Assistant and later Associate Professor of Law at the Department of Legal Studies and the Department of Economics and Business of the Central European University (CEU, 2012-2018). She holds a PhD in Comparative Private Law from Sant'Anna, an LL.M from the Yale Law School, and an LL.B and J.D from University of Pisa. Her research concerns international and comparative intellectual property law, with a focus on European copyright law, IP and new technologies (esp. AI and data science), the balance between IP and human rights, and data ownership and management in the era of big data.
- [Andrea Tenucci](#) is Associate Professor at the Institute of Management of of the Sant'Anna School. His main fields of research are cost accounting and management in servitizing contexts, strategic management accounting, performance measurement and accounting history. He is furthermore doing research on Integrated Reporting and ESG measures/reporting.
- [Andrea Vandin](#) is Associate Professor of Computer Science at the Institute of Economics of of the Sant'Anna School. He is also an Adjunct Associate Professor at [DTU Technical University of Denmark](#), where he held appointments as assistant and then associate professor before joining Sant'Anna. In the past, he was also a visiting Professor at the IMT School for Advanced Studies in Lucca. His research covers several areas of Computer Science, and he pursues an interdisciplinary approach, especially at the interfaces of Computer Science with the Social Sciences, and with Biology.

[Cristiana Bettelli](#) and [Guido Cei](#) are our Administrative Officers. Following the resignation of Daniele Licari, Pietro Amat supported our computational infrastructure on a temporary basis. Two new experts tasked with data management and computational infrastructure and research support will be recruited in 2024.



Finally, in 2023 as before, L'EMbeDS operated in close coordination with other units of the Sant'Anna School, in particular the **ICT Services**, which is involved in infrastructure acquisition and related coordination and training initiatives; the **Library**, which is involved in the acquisition and management of databases access; the **Purchasing Office**; the **Human Resources Office**, which is involved in recruitment; the **Technical Area Office** and the **Communication Office**.

L'EMbeDS is significantly broadening the research potential and the national and international profile IdE, IdM, Dirpolis, the Social Sciences Class and SSSA as a whole. In addition to the regular activities of the Managing Board, monitoring of the project involves the creation of ANNUAL REPORTS such as this one, which are available on the L'EMbeDS website (<https://www.santannapisa.it/it/dipartimenti-eccellenza/embeds>).

16. ONLINE PRESENCE AND MEDIA COVERAGE

WEBSITE:

We continue maintaining and expanding our website, which contains information on L'EMbeDS, its members, and relevant news and events (<https://www.santannapisa.it/it/dipartimenti-eccellenza/embeds>). Relatedly, we developed a new logo and graphic design for the second cycle – which is used on the website, as well as in printed and online materials. The website is a key communication tool that allows us to reach a broad community and advertise our initiatives, activities and progress. It is in constant evolution, and at this time it includes the following sections:

- WHO ARE WE? (profiles of people in leadership, extended community, recruits and administrative roles)
- EDUCATION (description of the education programs related to L'EMbeDS)
 - PhD programs related to L'EMbeDS
 - Courses in Statistics, Computing, Data Analytics and Modeling
 - II Level Honour Course in Data Science related to L'EMbeDS
- RESEARCH (description of main research areas, and of the challenges and opportunities of Big Data)
 - ONGOING PROJECTS AND GROUPS (description of ongoing projects and research groups)
 - RESEARCH THEMES (description of the core domain themes)
 - STAKEHOLDERS (connections with the private sector and relations with stakeholders)
 - INFRASTRUCTURE & RESOURCES (HPC Cluster and Multi-Function Laboratory)
- COVID-19 (a section added in 2020, which showcases a selection of relevant readings linked to the pandemic – including contributions by our community; a selection of relevant scientific literature repositories; a selection of relevant data repositories and data integration platforms and dashboards; and a selection of round tables, seminars, workshops and documentaries).
- OPENINGS (information on openings and recruitment)
- WORKSHOPS (L'EMbeDS related workshops, conferences and events)
- NEWS (news items concerning salient activities, events, publications, visitors, recruitment, etc.)
- ANNUAL REPORTS (Annual Reports repository)

MEDIA COVERAGE

Scientific output, contributions and events related to the L'EMbeDS community were presented in press releases and featured in various media outlets in 2023. Below we provide a selection of such coverage:

- RTV 38 - Dipartimenti di Eccellenza: Scuola Sant'Anna premiata dal MUR, accolte tutte e due le proposte presentate. Oltre 16 milioni di finanziamenti in arrivo, in aggiunta poco meno di 8 di entrate



Department
of Excellence
2023 - 2027

LEMbeDS

Economics, Management and
Law in the era of Data Science

proprie (<https://www.santannapisa.it/it/multimedia/rtv-38-dipartimenti-di-eccellenza-scuola-santanna-premiata-dal-mur-accolte-tutte-e-due>)

- International Day of Women and Girls in Science: Andrea Vandin presents two (unknown) female heroes of Computer Science (<https://www.santannapisa.it/it/news/international-day-women-and-girls-science-andrea-vandin-presents-two-unknown-female-heroes>)
- Cutting-edge research, the European Commission funds two ERC Starting Grant projects of the Sant'Anna School (<https://www.santannapisa.it/en/news/muse-find-progetti-erc-starting-grant>)