Irene Balelli

Ph.D.

Inria Center of University Côte d'Azur,
Epione Team
2004 Route des Lucioles,
06902 Valbonne, France
0033 602082747
irene.balelli@inria.fr
ibalelli.github.io

Biographical Information

Birth **November 3, 1988**, in Forlimpopoli - Italy.

Citizenship **Italian and French**.

Family sit. **Married. Two children** (2015 and 2018).

Research Interests

Modeling/ Statistics: Bayesian Statistics. Latent variable models. Generative models. Mixed effects models. Identifiability analysis. Sensitivity analysis. PK/PD. In-silico trials. Meta-modeling.

ML & Data governance: Causal learning. Graph-based learning. Federated learning. Distributed learning. Differential privacy. Large-scale heterogeneous biomedical data. Missing data.

Biomedical Applications: *Cardiology:* Drugs' cardiac safety. Pro-arrhythmic risk. Cardioembolic stroke. ECG data.
Neurodegenerative diseases: Alzheimer's Disease. Parkinson's Disease. Brain Imaging data.
Genetic-related diseases: FragileX Syndrome. Cancer. Multi-omics data.
Immunology: Immune system. Antibody affinity maturation. B-cells. Immune memory. Vaccination.

Probability: Random walks on graphs. Markov chains. Graph theory. Galton-Watson processes.

Current Position & Work experience

2021–now **Research scientist (ISFP) in mathematical modeling for computational biomedicine**, EPIONE team - Inria Center of University Côte d'Azur, Valbonne - France.

2020–2021 **Post-doctoral research fellowship in federated statistical learning for biomedical data**, EPIONE team - Inria Center of University Côte d'Azur, Valbonne - France.

2017–2019 **Post-doctoral research fellowship in modeling of the immune response to Ebola vaccine**, SISTM team - Inserm U1219 Bordeaux Population Health, Bordeaux - France.

Education

2017 **Qualification**, CNU section 26: Applied mathematics and applications of mathematics.

2013–2016 **PhD in Applied Mathematics**, *LAGA - University Paris 13*, France, PhD thesis: *Mathematical foundations of antibody affinity maturation* (Supervisors: V. Milišić, G. Wainrib, H. Zaag).

2011–2013 **Master Degree in Mathematics Applied to Biology and Medicine**, *University Paris 6*, France, Master thesis: *A mathematical model of somatic hypermutation* (Supervisors: V. Milišić, G. Wainrib).

2010–2011 **Erasmus Program**, Universidad Complutense, Department of Mathematics, Spain.

2007–2010 **Bachelor degree in Mathematics**, *University of Bologna*, Italy, Bachelor thesis: *Bressloff and Cowan's model: visual hallucinations as stable states of cortical activation* (Supervisor: G. Citti).

Papers, Book Chapters and Preprints –> ;

†S. Al-Ali, J. Rodríguez Padilla, M. Sermesant, **I. Balelli**, *Cardiac Electromechanical Model Sensitivity Analysis using Causal Discovery*, Accepted in Functional Imaging and Modeling of the Heart (FIMH) 2025.

I. Balelli, S. Al-Ali, E. Dumas, J. Abecassis, *Causality: fundamental principles and tools*, Trustworthy AI in Medical Imaging, 2024, MICCAI/Elsevier book series, [hal-04831368].

†S. Al-Ali, M. T. Mora, M. Sermesant, B. Trénor, **I. Balelli**, *Assessing ion channel blockade and electromechanical biomarkers' interrelations through a novel Multi-Channel Causal Variational Autoencoder*, Computing in Cardiology (CinC) 2024, [hal-04607082].

Y. Coudière, M. Leguèbe, **I. Balelli**, A. Baretta, G. Fauré, D. Feuerstein, *A computer model for in-silico trials on pacemaker energy efficiency*, Computing in Cardiology (CinC) 2024, [hal-04886140].

A. Baretta, Y. Coudière, O. Camara, B. Trenor, H. Arevalo, **I. Balelli**, R. Setzu, L. Geris, S. Benito, M. Barbier, M. Sermesant, *SimCardioTest cloud-based platform: an innovative tool for cardiac in silico trials*, Abstract, VPHi Conference 2024.

S. Al-Ali, **I. Balelli**, *Multi-Channel Causal Variational Autoencoder*, In preparation, [hal-04666466].

†S. Al-Ali, J. Llopis-Lorente, M. T. Mora, M. Sermesant, B. Trénor, **I. Balelli**, *A causal discovery approach for streamline ion channels selection to improve drug-induced TdP risk assessment*, IEEE Xplore2023 - Computing in Cardiology (CinC) 2023 [hal-04105144].

†F. Cremonesi, M. Vesin, S. Cansiz, Y. Bouillard, **I. Balelli**, L. Innocenti, S. Silva, S.S. Ayed, R. Taiello, L. Kameni, R. Vidal, F. Orlhac, C. Nioche, N. Lapel, B. Houis, R. Modzelewski, O. Humbert, M. Onen, and M. Lorenzi, *Fed-BioMed: Open, Transparent and Trusted Federated Learning for Real-world Healthcare Applications*, To appear in: Federated Learning Systems - *Towards Privacy-Preserving Distributed AI*, Springer, 2025, [hal-04081557].

†**I. Balelli***, A. Sportisse*, F. Cremonesi, P.A. Mattei, M. Lorenzi, *Fed-MIWAE: Federated Imputation of Incomplete Data via Deep Generative Models*, In preparation, [hal-04069795].

Q. Clairon, C. Pasin, **I. Balelli**, R. Thiébaut, M. Prague, *Parameter estimation in nonlinear mixed effect models based on ordinary differential equations: an optimal control approach*, Computational Statistics, 2024, 39(6), 2975-3005 (COST).

M. Lorenzi, M. Deprez, **I. Balelli**, A. L. Aguila, A. Altmann, *Integration of Multimodal Data*, Machine Learning for Brain Disorders, 2023, 573-597, Springer Nature.

†**I. Balelli**, S. Silva, M. Lorenzi, *A Differentially Private Probabilistic Framework for Federated Heterogeneous Multi-View Datasets Variability*, Journal of Machine Learning for Biomedical Imaging (MELBA). 2022:012.

†**I. Balelli**, S. Silva, M. Lorenzi, *A Probabilistic Framework for Modeling the Variability Across Federated Datasets of Heterogeneous Multi-View Observations*, International Conference on Information Processing in Medical Imaging (IPMI). Springer, Cham, 2021. p. 701-714.

M. Prague*, J. Gerold*, **I. Balelli**, C. Pasin, J. Li, D. Barouch, J. Whitney, A. Hill, *Viral rebound kinetics following single and combination immunotherapy for HIV/SIV*, [bioRxiv 700401].

I. Balelli, C. Pasin, M. Prague, F. Crauste, T. Van Effelterre, V. Bockstal, L. Solforosi, R. Thiébaut, *A model for establishment, maintenance and reactivation of the immune response after vaccination against Ebola virus*, Journal of Theoretical Biology, 2020, DOI: 10.1016/j.jtbi.2020.110254.

C. Pasin, **I. Balelli**, T. Van Effelterre, V. Bockstal, L. Solforosi, M. Prague, M. Douoguih, R. Thiébaut, *Dynamics of the humoral immune response to a prime-boost Ebola vaccine: quantification and sources of variation*, Journal of Virology, 2019, **DOI:** 10.1128/JVI.00579-19.

I. Balelli, V. Milišić, G. Wainrib, *Multi-type Galton-Watson processes with affinity-dependent selection applied to antibody affinity maturation*, Bulletin of Mathematical Biology, 2019, vol. 81, no 3, p. 830-868.

I. Balelli, V. Milišić, G. Wainrib, *Random walks on binary strings applied to the somatic hypermutation of B-cells*, Mathematical Biosciences, 2018, vol. 300, p. 168-186.

I. Balelli, V. Milišić, G. Wainrib, *Branching random walks on binary strings for evolutionary processes in adaptive immunity*, [arXiv: 1607.00927].

† This paper is listed within the 3IA Côte d'Azur collection.

Conferences, Meetings and Seminars

2024 **IABM 2024**, *Invited talk*, Grenoble.

i2m Seminar, *Invited talk*, Marseille.

HeKa Seminar, *Invited talk*, Online.

2023 **Innovaheart 2023**, *Invited talk*, Bordeaux.

3IA Seminar, *Invited talk*, Sophia Antipolis.

2022 **Inria-DFKI workshop 2022**, Bordeaux.

BoostUrCareer Doctoriales 2022 – AI in HEALTHCARE, *Invited talk*, Nice.

2021 **Information Processing in Medical Imaging (IPMI) 2021**, Online event.

2020 **3IA Scientific Days**, Nice - France.

SophI.A Summit 2020, Sophia Antipolis - France.

2019 **4$^{\text{th}}$ EBOVAC1/2 Annual meeting**, *Invited talk*, Nairobi - Kenya.

VRI Annual meeting, *Invited talk*, Paris - France.

2018 **IMI 10$^{\text{th}}$ Anniversary Scientific Symposium**, 3$^{\text{rd}}$ committee prize "best presentation", Brussels - Belgium.

CROI 2018, *Poster (J.M. Gerold, C. Pasin,* ***I. Balelli****, S. Lim, C. Osuna, J.B. Whitney, D.H. Barouch, M. Prague, A.L. Hill)*, Boston - United States.

3$^{\text{rd}}$ EBOVAC1/2 Annual meeting, *Invited talk (with C. Pasin)*, Amsterdam - Nederland.

2017 **Systems Immunology and Vaccine design**, Heidelberg - Germany.

2016 **Probabilities and Statistics seminar (LAGA)**, *Invited talk*, Villetaneuse - France.

1$^{\text{st}}$ Challenges in inflammation meeting, Florence - Italy.

Les probabilités de demain, *Invited talk*, IHÉS - Bures-sur-Yvette - France.

Summer school: "PDE and Probability for Life Sciences", CIRM - Marseille - France.

2015 **EDP-Normandie**, Havre - France.

2014 **InflaConf: Mathematical modeling in immunology and inflammation**, *invited talk*, Paris - France.

CANUM 2014, Carry-le-Rouet - France.

Inflamex day, *Invited talk*, CIEP Sèvres - France.

2013 **GDR Métice: Inflammation and Treatment Resistance**, *invited talk*, Lyon - France.

Thematic schools: contribution

2022 **AI4Health Winter School**, *Workshop (teaching materials and presentation):* Fed-BioMed, an open source framework for federated learning in real world healthcare applications, Online event.

2021 **AI4Health Winter School**, *Workshop (teaching materials and presentation):* Handling heterogeneity in the analysis of biomedical information, Online event.

First Inria-DFKI European Summer School on Artificial Intelligence, *Workshop (teaching materials and presentation):* Federated learning methods and frameworks for collaborative data analysis, Online event.

Supervision activities

Post-Doc **S. Al-Ali**, *Causal data analysis of in-silico trials*, Since Oct. 2022 (100% supervision).

PhD **W. Kahtir**, *Integromics analysis: a new angle for studying the pathophysiology of Fragile X Syndrome*, co-directed with C. Gwizdek (IPMC) and M. Lorenzi, Since Mar. 2024 (50% supervision)‡.

E. Gaymard, *Innovative mathematical methodologies in pharmacometric meta-modeling from highly heterogeneous sources*, industrial PhD (CIFRE) with Exact-Cure, co-directed with M. Sermesant, Nov. 2022 - Jun. 2023 (50% supervision).

Master 2 **A. Lang**, *Voting strategy for causal discovery with uncertainty*, Apr. 2025 - Sept. 2025 (100% supervision).

B. Ramudu Manam, *PPCA-based disease progression modeling*, Apr. 2023 - Sept. 2023 (50% supervision).

A. Senacheribbe, *Longitudinal PPCA*, Sept. 2020 - Feb. 2021 (50% supervision).

M. Alexandre, *Mechanistic modeling for vaccinology*, Feb. 2019 - Aug. 2019 (20% supervision).

Master 2, Res. Proj. **I. Illahibuccus-Sona**, *Semi-supervised multi-modal VAE*, Nov. 2024 - Apr. 2025 (100% supervision).

H. Hammed, *Causal inference with application to drug-induced proarrhythmic risk*, Nov. 2024 - Apr. 2025 (50% supervision).

‡ I am committed with the doctoral school ED SVS and UniCA to defend my HDR by 2026.

Teaching Activities

2023-2025 **Advanced statistical modeling**, *Lectures and tutorials (20h/year)*, 3rd year bachelor's degree (BUT Data science), University Côte d'Azur, Sophia Antipolis - France.

Statistical modeling for complex data and Big Data, *Lectures and tutorials (33h/year)*, 3rd year bachelor's degree (BUT Data science), University Côte d'Azur, Sophia Antipolis - France.

Research awareness, *Talks and demos (6h/year)*, M1-M2, EURECOM, Sophia Antipolis - France.

2020-2024 **Bayesian learning**, *Lectures and tutorials (10h/year)*, M2 MSc Data Science & Artificial Intelligence, University Côte d'Azur, Sophia Antipolis - France.

2020-2023 **Modeling of biological systems**, *Lectures and tutorials (10h/year)*, M2 BIM, University Côte d'Azur, Nice - France.

2022-2023 **Statistics and Modeling**, *Tutorials (24h/year)*, 3rd year bachelor's degree, University Côte d'Azur, Nice - France.

2021-2022 **Analysis and Modeling**, *Tutorials (20h/year)*, 1st year bachelor's degree, University Côte d'Azur, Nice - France.

2013-2016 **Teaching mission proposed to PhD students (*Monitorat* - Tutorials 64h/year)**.

Probability and Statistics 2, *Tutorials*, 2nd year bachelor's degree in Mathematics and MIEF, University Paris 13, Villetaneuse - France.

Probability and Statistics 1, *Tutorials*, 2nd year bachelor's degree in Mathematics, University Paris 13, Villetaneuse - France.

Probability and Statistics, *Tutorials*, 1st year Engineering degree (Apprentissage énergétique), Engineering School Sup Galilée, Villetaneuse - France.

Statistics, *Tutorials*, 1st year Engineering degree MACS (Mathématiques Appliquées et Calcul Scientifique), Engineering School Sup Galilée, Villetaneuse - France.

Probability, *Tutorials*, 2nd year IUT-Info, University Paris 13, Villetaneuse - France.

Inferential statistics, *Tutorials*, 2nd year DUT-GEA, University Paris 13, Bobigny - France.

Review Activities

PC Member for the ECAI 2024 (Outstanding PC Member Award), ECAI 2025.

Computers in Biology and Medicine (Elsevier), Vaccine (Elsevier), Medical Image Analysis (Elsevier), Neuroimage (Elsevier), SMAI J. of Computational Mathematics

Softwares

MC^{2}VAE Variational causal disentanglement from multimodal data: design and code.

Fed-mv-PPCA Bayesian framework for federated multi-view heterogeneous datasets assimilation based on Probabilistic PCA: design and code.

Fed-BioMed Open-source federated learning framework: participation to research and development.

Responsabilities and Management

Administration In charge of the pedagogical organization of the AI for Health track of the Data Science&AI (DSAI) Master 2 since 2023, Université Côte d'Azur, Sophia Antipolis - France

SC Part of the scientific committee of the GIS (scientific interest group) FC3R since Jul. 2023.

Part of the scientific committee of the Academy 2 (Complex Systems) since Nov. 2023.

OC Member of the organizing committee of the Complex days, Nice, Feb. 2025.

Member of the organizing committee of the spring school GeMSS/Statlearn, Sophia Antipolis, Apr. 2025.

Juries Member of the admissibility jury for the 2025 recruitment campaign for researchers, Inria center of University Côte d'Azur.

Member of the PhD jury of H. Liu (Paris - May 2024).

Member of the PhD jury of V. Montalibet (Bordeaux - scheduled September 2024).

Member of the DSAI Master 2 jury (recruitment and evaluation) since 2023.

National & International Projects and Collaborations

2024-now **Academic:** C. Gwizdek, Institut de Pharmacologie Moléculaire et Cellulaire (IPMC) (France).
M. Mousavi, King's College London (UK).
R. Ramos, Instituto Federal de São Paulo (Brazil).

2024-now **TALENT**, *RHU France 2030 programme*, 8 French partners, 1 USA.
Role: WP co-leader, Multimodal risk prediction model
Clinic: Bordeaux University Hospital (France).

2021–now **SimCardioTest**, *EU H2020 programme*, 10 organizations, 6 EU countries and USA.
Role: WP leader, In-silico trials & Data science
Academic: Center for Research and Innovation in Bioengineering (Ci2B), Universitat Politècnica de València (Spain).
Industry: InSilicoTrials (Italy).

2018–2019 **DYNAM-HIC**, *Inria Associate team*, France and USA.
Academic: Harvard Program for evolutionary Dynamics (USA).

2017–2019 **Ebovac**, *IMI Ebola+ programme*, 6 partners, EU, UK, Sierra Leone, Burkina Faso.
Academic: Oxford Vaccine Group (UK).
Industry: Janssen Vaccines & Prevention B.V. (Belgium).
Clinic: Vaccine Research Institute (VRI, France).

2013–2016 **Inflamex**, *Laboratory of Excellence (LabEx)*, France.
Clinic: Inserm UMR-U978 Signaling Adapters in Hematology (ASIH, France).

Outreach activities

2025 AI'm in France, Why do researchers from around the world choose France for their research in #IA? Video for IA Summit 2025, Paris, France.

2022 1 scientifique 1 classe: Chiche!, to encourage the pursuit of scientific studies and explain research activities to high school students. 3 classes, Lycée Tocqueville, Grasse, France.

Computer Skills

Programming **Python, Matlab, R**

Editing & Office **Office, LaTeX, OpenOffice**

Operating Systems **Mac 0SX, Linux, Windows**

Others **Monolix, IdentifiabilityAnalysis (Mathematica), DAISY (Reduce3.8)**

Languages

Italian	**Mother tongue**	English	**Fluent**
French	**Bilingual**	Spanish	**Fluent**