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eXperience in the second period



Dear Colleagues,

I am thrilled to share with you the latest news about our successful project, EXPERIENCE. We have recently completed the first review meeting, and I am happy to report that the outcome was a resounding success. Our project has progressed well in all work packages, and the results are truly inspiring.

I am also delighted to share that our publication list and dissemination activities are significantly increasing, and our project is having a notable impact on the scientific community. It is an honor to be part of such an impactful and meaningful endeavor.

Moreover, we are part of a cross-collaboration project with four other consortia, which provides us with a fantastic opportunity to learn and grow. By working together and sharing our knowledge and resources, we can achieve more than we could ever do on our own.

As we move forward, I hope you share my enthusiasm and excitement for this project. I look forward to continuing to work with each and every one of you to make EXPERIENCE a success. Please take a moment to review our newsletter.

Thank you for your continued dedication and commitment to this project.

The project Coordinator
Gaetano Valenza

A handwritten signature in black ink that reads "Gaetano Valenza".



To subscribe to the newsletter go the eXperience website and follow the "Newsletter" link.

Contact: simona.moschini@unipi.it





Name: Gaetano
Surname: Valenza
Title: Professor
Affiliation: University of Pisa – Research Center «E.Piaggio»

1. Favorite areas of interest and research

Biomedical signal and image processing, physiologically-inspired artificial intelligence, - Cardiovascular and Neural Modeling.

2. Can you mention some of the most promising research directions in the biosignal processing field?

Assessment of causal brain-body interplay, provide specificity in pathology biomarkers.

3. Which innovation influenced mostly your scientific world in the last 10-20 years?

Over the last two decades, machine learning and artificial intelligence (AI) algorithms have revolutionized biomedical signal and image processing. They have allowed us to make significant strides in the analysis, interpretation, and diagnosis of complex biological signals and images, which were previously difficult to understand. For instance, they enable the identification of subtle patterns and trends in data sets generated by medical imaging devices that are not apparent to the human eye or traditional processing methods. However, a potential drawback of AI in biosignal processing is that the models can be highly complex, leading to interpretability issues that may make it challenging for researchers and clinicians to understand how the algorithms are making decisions. Nonetheless, I am proud that in the EXPERIENCE project, we are making significant advancements towards interpretable AI and biosignal processing, which will ultimately contribute to improved patient outcomes and better overall health.

4. What was your motivation to become the researcher?

Love for science and new discoveries.

5. eXperience is....

This research project brings together exceptional researchers from diverse fields, each with a clear vision and well-defined objectives. The project offers an unparalleled opportunity for idea exchange, where researchers can share their insights, engage in constructive debate, and engage in productive collaboration. By creating an environment of open communication and knowledge sharing, the project fosters a culture of "give and take" that allows everyone to learn from each other's experiences and expertise. Together, we are working towards a common goal, leveraging our collective strengths to make a significant impact in our respective fields.



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1. My favorite non-scientific book, musician and movie...

Book: The picture of Dorian Gray

Musician: Bruce Springsteen, Vasco Rossi

Movie: Remember the Titans (200)

2. I like to spend my free-time / vacation in....

Mountain (Italian Dolomiti), Sicily, Maryland (USA)

3. My favorite course (meal)...

Pizza

4. The character trait I really dislike....

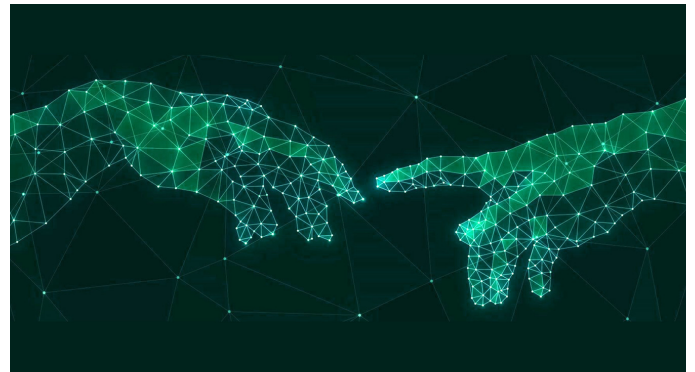
arrogance, know-it-all people

5. A best sentence...

Be contented with what you have got and make the best of it.

Look on the bright side of things instead of the gloomy one. -

Author: Robert Baden-Powell



PEOPLE

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Gaetano Valenza

Gaetano Valenza received the M.Eng. And Ph.D. degrees from the University of Pisa, Pisa, Italy. He is currently an Associate Professor with the Department of Information Engineering, University of Pisa, and the Head of the Neuro-Cardiovascular Intelligence Laboratory. His research interests include statistical and non-linear biomedical signal and image processing, cardiovascular and neural modeling, physiologically interpretable artificial intelligence systems, and wearable systems for physiological monitoring.



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Mario Cimino

Mario G.C.A. Cimino is an Associate Professor of Information Processing Systems at the University of Pisa, where he researches Information Systems and Artificial intelligence. He is also a research associate at the Italian National Research Agency and an Associate Editor of two scientific journals. He has authored about 70 scientific publications and is a co-founder of the "Machine Learning and Process Intelligence" Initiative at the University of Pisa.

Participation in eXperience WPs: WP1, WP2, WP3.



Matteo Bianchi

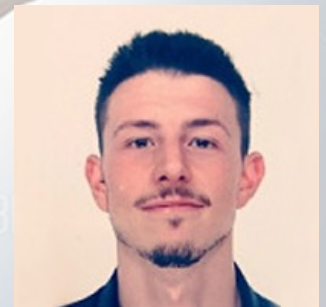
Matteo Bianchi is an Associate Professor at the University of Pisa, where he researches haptic interface and sensor design for applications in virtual reality, medical robotics, and assistive robotics. He has authored over 150 peer-reviewed publications and is the Principal Investigator of numerous research grants and contracts. He has also served in leadership roles for two IEEE technical committees and is a recipient of several national and international awards.

Participation in eXperience WPs: WP1, WP2

Antonio Luca Alfeo

Antonio Luca Alfeo is an Assistant Professor of the Department of Information Engineering, University of Pisa (Machine Learning and Process Intelligence research group). His research interest addresses the design of machine learning approaches to analyze physiological, industrial, and behavioral data via Explainable Artificial Intelligence and Deep Representation Learning.

Participation in eXperience WPs: WP2, WP3



Simona Moschini

Simona has worked over 17 years as Project Manager both in private and public Institutions with a specialization in management of research and development projects, with particular reference to the European programmes. She is also an administrative and financial expert and contributes to the communication and dissemination of research results.

Participation in eXperience WPs: WP5, WP6

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Research topics

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& IDEAS

Learnable latent embeddings for joint behavioural and neural analysis

Mapping behavioural actions to neural activity is a fundamental goal of neuroscience. As our ability to record large neural and behavioural data increases, there is growing interest in modelling neural dynamics during adaptive behaviours to probe neural representations^{1–3}. In particular, although neural latent embeddings can reveal underlying correlates of behaviour, we lack nonlinear techniques that can explicitly and flexibly leverage joint behaviour and neural data to uncover neural dynamics^{3–5}. Here, we fill this gap with a new encoding method, CEBRA, that jointly uses behavioural and neural data in a (supervised) hypothesis- or (self-supervised) discovery-driven manner to produce both consistent and high-performance latent spaces. We show that consistency can be used as a metric for uncovering meaningful differences, and the inferred latents can be used for decoding. We validate its accuracy and demonstrate our tool's utility for both calcium and electrophysiology datasets, across sensory and motor tasks and in simple or complex behaviours across species. It allows leverage of single- and multi-session datasets for hypothesis testing or can be used label free. Lastly, we show that CEBRA can be used for the mapping of space, uncovering complex kinematic features, for the production of consistent latent spaces across two-photon and Neuropixels data, and can provide rapid, high-accuracy decoding of natural videos from visual cortex.

Schneider, S., Lee, J. H., & Mathis, M. W. (2023). Learnable latent embeddings for joint behavioural and neural analysis. *Nature*, 1-9.

Cardiogenic control of affective behavioural state

Emotional states influence bodily physiology, as exemplified in the top-down process by which anxiety causes faster beating of the heart. However, whether an increased heart rate might itself induce anxiety or fear responses is unclear. Physiological theories of emotion, proposed over a century ago, have considered that in general, there could be an important and even dominant flow of information from the body to the brain⁹. Here, to formally test this idea, we developed a noninvasive optogenetic pacemaker for precise, cell-type-specific control of cardiac rhythms of up to 900 beats per minute in freely moving mice, enabled by a wearable micro-LED harness and the systemic viral delivery of a potent pump-like channelrhodopsin. We found that optically evoked tachycardia potently enhanced anxiety-like behaviour, but crucially only in risky contexts, indicating that both central (brain) and peripheral (body) processes may be involved in the development of emotional states. To identify potential mechanisms, we used whole-brain activity screening and electrophysiology to find brain regions that were activated by imposed cardiac rhythms. We identified the posterior insular cortex as a potential mediator of bottom-up cardiac interoceptive processing, and found that optogenetic inhibition of this brain region attenuated the anxiety-like behaviour that was induced by optical cardiac pacing. Together, these findings reveal that cells of both the body and the brain must be considered together to understand the origins of emotional or affective states. More broadly, our results define a generalizable approach for noninvasive, temporally precise functional investigations of joint organism-wide interactions among targeted cells during behaviour.

Hsueh, B., Chen, R., Jo, Y., Tang, D., Raffiee, M., Kim, Y. S., ... & Deisseroth, K. (2023). Cardiogenic control of affective behavioural state. *Nature*, 1-8.

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FLASH NEWS

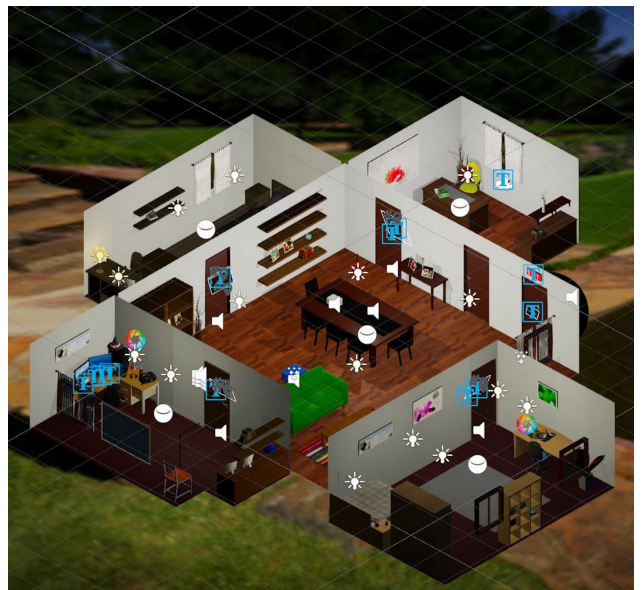
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EXPERIENCE Wearable System has passed the Safety and EMC tests

We are thrilled to hear that the EXPERIENCE system has passed the Safety and EMC tests. This achievement is a critical milestone for the project, and it brings us one step closer to achieving our shared goal of providing a system to record and transmit the individual's extended personal reality. Well done, CSEM!

A complete VR environment for clinical investigation

Thanks to our colleagues at UPV, we now completed the EXPERIENCE test VR environment. This cutting-edge platform enables us to investigate physiological and behavioral data in clinical populations, including individuals suffering from depression. By leveraging the power of VR technology, we are now able to study complex human behaviors in a more naturalistic setting, providing us with valuable insights that would have been impossible to obtain using traditional methods. We are confident that the data generated by this platform will pave the way for significant advancements in the diagnosis, treatment, and understanding of mental health disorders. Once again, our heartfelt thanks go out to our colleagues at UPV for their invaluable contributions to this project.



Joint publication UNIPI-UNITOV on Explainable AI and Brain signals!

Alfeo, A. L., Zippo, A. G., Catrambone, V., Cimino, M. G., Toschi, N., & Valenza, G. *From local counterfactuals to global feature importance: efficient, robust, and model-agnostic explanations for brain connectivity networks*. *Computer Methods and Programs in Biomedicine*, 107550, 2023.

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Last&Next Events

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25-28 April 2023 | Baltimore, USA

NER 2023

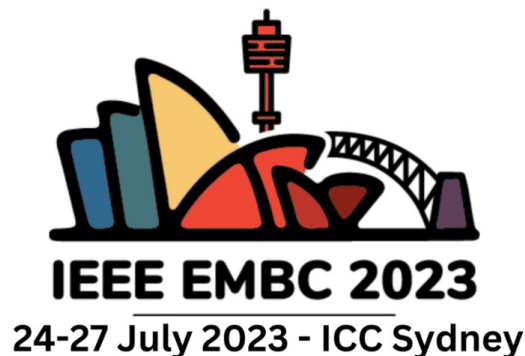
NER is the world's gathering place for biomedical engineers, neuroscientists, and clinicians to share research and to exchange ideas and breakthrough advances in novel engineering tools for elucidating brain function and neurotechnologies for the restoration and the advancement of impaired sensory, motor, and cognitive functions.



24-27 July 2023 | Sydney, AUSTRALIA

EMBC 2023 – The IEEE Engineering in Medicine and Biology Society

The biomedical engineering community of Australia and New Zealand has a long history of outstanding scientific and technological contributions and is supported by a vibrant medtech industry. In reflection of how the global pandemic highlighted fragilities in global healthcare systems and responses worldwide, the theme of the conference is “Engineering Better and More Resilient Healthcare for All.”



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