



MICROBIOME

<https://www.cost.eu/actions/CA18131/>



Statistical and machine learning techniques in human microbiome studies

Start of Action 22/02/2019
End of Action 21/02/2023

COST Action CA18131

WG4 Leader: Domenica D'Elia

BITS 2023 Conference: 21-23 June 2023, Bari (iT)



Growing **ideas**
through **networks**



The longest-running European
Framework for Cooperation in
Science & Technology

- Connect high-quality scientific communities across Europe (and beyond) on societal & scientific challenges
- Provide networking opportunities
- To increase research impact on:
 - policy makers
 - regulatory bodies
 - national decision makers
 - private sector



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ML4MICROBIOME ACTION OVERVIEW

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Statistical and machine learning techniques in human microbiome studies

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Action Details

- **MoU** - 112/18
- **CSO Approval date** - 13/11/2018
- Start date - 22/02/2019 End date - 21/08/2023

* **COST Inclusiveness Target Countries (ITCs)**: Albania, Bosnia and Herzegovina, Bulgaria, Cyprus, Czech Republic, Estonia, Croatia, Hungary, Lithuania, Latvia, Luxembourg, Malta, Moldova, Montenegro, Poland, Portugal, Romania, Slovenia, Slovakia, Republic of North Macedonia, Republic of Serbia and Turkey.

- Presentations
- Meetings & Workshops
- Training
- STSM Grants
- ITC Grants
- VNS Tools
- Dissemination Grants

ML4Microbiome Cost Action Aim

To first optimize and then standardize best practice of ML techniques for human microbiome research

ML4Microbiome website

	Start	Now
Countries	24	35
Participants	57	169
ITC*	54%	55%





COST Action CA18131

Working Group 1 (WG1)

Evaluation of state-of-the-art ML methods

- Define priority areas for ML applications
- Review newly released publications and software
- Provide reports on novel advances and applications

Working Group 2 (WG2)

Collection and description of microbiome datasets

- Benchmark datasets and online repositories
- Setting up a DREAM challenge

gives recommendations

Working Group 4 (WG4)

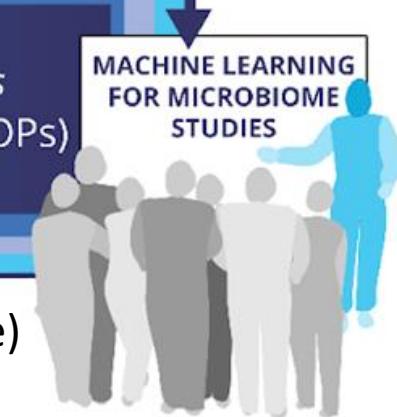
Bridge gaps between ML and microbiome experts

- Disseminate the results of the COST action
- Training courses, workshops, and public relations
- Distill knowledge of WGs into "best practice" papers

Working Group 3 (WG3)

Optimization and standardization of ML methods

- Work on standard operating procedures (SOPs)
- Automate SOPs into pipelines



✓ Publications - ML4 Microbiome (12 and many others in progress including one perspective article)

CONTACT INFORMATION

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- Pfeil J, Siprotto J, Pospisil H, Frohme M, Hufert FT, Moskalenko O, Yateem M, Nechyporenko A. **Classification of Microbiome Data from Type 2 Diabetes Mellitus Individuals with Deep Learning Image Recognition**. *Big Data and Cognitive Computing*. 2023; 7(1):51. <https://doi.org/10.3390/bdcc7010051>
- *Frontiers in Genetics* volume – Research Topic: Microbiome and Machine Learning (2022) – 10 articles published. *Microbiome and Machine Learning | Frontiers Research Topic* (frontiersin.org)
- Moreno-Indias I., Zomer AL., Gómez-Cabrero D., Claesson MJ on behalf of ML4Microbiome (2022) Editorial: **Microbiome and Machine Learning Research Topic**. *Front. Microbiol.*, Sec. Evolutionary and Genomic Microbiology. <https://doi.org/10.3389/fmicb.2022.964921>
- Cekikli Miodrag, Jakimovska Özdemir, Milena Kalajdziski, Slobodan Özcan, Orhan Sezerman, Osman Uğur (2022) Understanding the Role of the Microbiome in Cancer Diagnostics and Therapeutics by Creating and Utilizing ML Models. *Appl. Sci.* 12(9), 4094; <https://doi.org/10.3390/app12094094>
- Vilne Baiba, Kibiles Juris, Siksna Inese, Lazda Ilva, Valcija Olga, Krūmiņa Angelika (2022) Could Artificial Intelligence/Machine Learning and Inclusion of Diet-Gut Microbiome Interactions Improve Disease Risk Prediction? Case Study: Coronary Artery Disease. *Frontiers in Microbiology*. 13. doi:10.3389/fmicb.2022.627892
- Ibrahim E., Elbere I., Berland M., & D'Elia D. (2022) Report of the ML4Microbiome workshop 2021 – Statistical and Machine Learning Techniques for Microbiome Data Analysis. *EMBnet.journal*, 27, e1012. doi:<https://doi.org/10.14806/ej.27.0.1012>
- Rosario D, Beldkhorri G, Lee S, Bedarf J, Hildebrand F, Le Chatelier E, Uhlen M, Ehrlich SD, Proctor G, Wüllner U, Mardinioglu A, Shoae S. **Systematic analysis of gut microbiome reveals the role of bacterial folate and homocysteine metabolism in Parkinson's disease**. *Cell Rep*. 2021 Mar 2;34(9):108807. doi: 10.1016/j.celrep.2021.108807. PMID: 33657381.

- 4 Training Schools
- 16 awarded Short Term Scientific Mission grants
- 3 Virtual Mobility grants
- 3 Inclusiveness Target Countries (ITC) grants (dissemination)
- DREAM Challenge: ML4Microbiome Finrisk DREAM Challenge

FINRISK - Heart Failure and Microbiome - syn27130803
- Wiki (synapse.org)



MICROBIOME

✓ Training Material accessible from the Action website

✓ [Training Material - ML4 Microbiome](#)

✓ YouTube Playlists:

[\(560\) ML4Microbiome Workshop 2021 – YouTube](#)

[\(560\) ML4Microbiome Symposium 2021 – YouTube](#)

The image shows a screenshot of the ML4Microbiome YouTube channel. The channel has 97 subscribers and is associated with COST Action CA18131. It features several video thumbnails, each with a title, view count, and upload date. The videos cover topics such as 'ML4Microbiome - Training in microbiome analysis / Leo Lahti' (24 views, 1 year ago), 'Welcome, Brief Description of ML4Microbiome & Introduction to the Workshop - Domenica D'Elia' (150 views, 1 year ago), 'COST Action ML4Microbiome - an opportunity for collaboration on training: Domenica D'Elia' (18 views, 2 years ago), 'Statistical analysis of the microbiome data with R - Eliana Ibrahim' (1.9K views, 1 year ago), 'Overview of the microbiome data - Ilze Elbere' (205 views, 1 year ago), and 'Outline | The Microbiome | What is the aim? | Study design | Design - case/control | The perfect...' (22 moments).

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ML4Microbiome - Training in microbiome analysis / Leo Lahti
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Training in Microbiome Analytics | Training in Microbiome Analysis | Elements of Microbiome Data... 7 moments

Welcome, Brief Description of ML4Microbiome & Introduction to the Workshop - Domenica D'Elia
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Statistical analysis of the microbiome data with R - Eliana Ibrahim
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ML4Microbiome Workshop 2021 - 15 October 2021.
Visualization of microbiome data | Statistical hypothesis testing | Sample size and power analysis... 12 moments

Overview of the microbiome data - Ilze Elbere
205 views • 1 year ago
ML4Microbiome
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Outline | The Microbiome | What is the aim? | Study design | Design - case/control | The perfect... 22 moments



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Microbiome and Machine Learning, Volume II



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Views

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Overview Articles Authors Impact

About this Research Topic

Abstract Submission Deadline 30 June 2023
Manuscript Submission Deadline 31 October 2023

Guidelines >

Due to the success of [Microbiome and Machine Learning](#), which collected research results and perspectives of researchers working in the field of machine learning (ML) applied to the analysis of microbiome data, we are launching the second volume to collate any new findings in the field to further our understanding and encourage the participation of experts worldwide in the discussion.

The success of ML algorithms in the field is substantially due to their capacity to process high-dimensional data and deal with uncertainty and noise. However, to maximize the combinatorial potential of these emerging fields (microbiome and ML), researchers have to deal with some aspects that are complex and inherently related to microbiome data. Microbiome data are convoluted, noisy and highly variable, and non-standard analytical methodologies are required to unlock their clinical

frontiersin.org

Topic Editors:

Domenica D'Elia, Isabel Moreno Indias, Marcus Claesson, Aldert Zomer, Erik Bongcam-Rudloff, Randi Jacobsen Bertelsen

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Participating Journals

Manuscripts can be submitted to this Research Topic via the following journals:

Frontiers in
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Evolutionary and Genomic Microbiology
Systems Microbiology

Frontiers in
Genetics

[Microbiome and Machine Learning |](#)
[Frontiers Research Topic](#)
[\(frontiersin.org\) – Volume II \(2023\)](#)

Deadline for submission: October 2023

The collection will include:

- Original Research
- Methods
- Reviews
- Technology and Code
- Perspective

Describing machine learning novel tools or approaches for analysing and classifying microbiome data, improving the interpretability of ML application results, or employing Explainable AI

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Microbiome and Machine Learning

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10 Articles

EDITORIAL
Published on 05 Jul 2022

Editorial: Microbiome and Machine Learning

Isabel Moreno-Indias · Aldert L. Zomer · David Gómez-Cabrero · Marcus J. Claesson

ORIGINAL RESEARCH
Published on 21 Jan 2021

DeepT3_4: A Hybrid Deep Neural Network Model for the Distinction Between Bacterial Type III and IV Secreted Effectors

Lezheng Yu · Fengjuan Liu · Yizhen Li · Tianshu Li · Dandan Tang

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TECHNOLOGY AND CODE
Published on 28 Jan 2021

kernInt: A Kernel Framework for Integrating Supervised and Unsupervised Analyses in Spatio-Temporal Metagenomic Datasets

[Microbiome and Machine Learning | Frontiers Research Topic \(frontiersin.org\) – Volume I](#)

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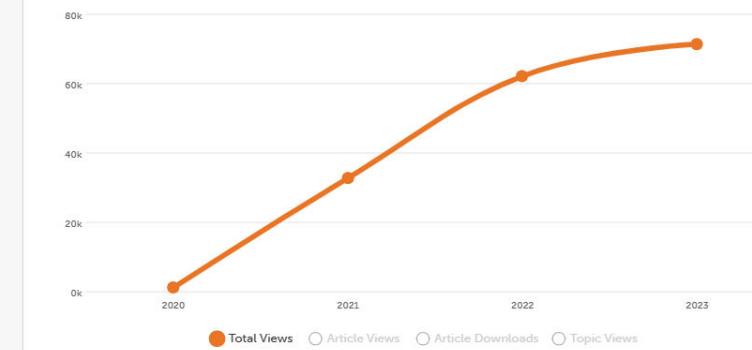

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Statistical and Machine Learning Techniques in Human Microbiome Studies: Contemporary Challenges and Solutions

Isabel Moreno-Indias , Leo Lahti , Miroslava Nedyalkova, Ilze Elbere , Gennady Roshchupkin , Muhamed Adilovic , Onder Aydemir , Burcu Bakir-Gungor , Enrique Carrillo-de Santa Pau , Domenica D'Elia , Mahesh S. Desai , Laurent Falquet , Aycan Gundogdu , Karel Hron , Thomas Klammsteiner , Marta B. Lopes , Laura Judith Marcos-Zambrano , Cláudia Marques, Michael Mason , Patrick May , Lejla Pašić , Gianvito Pio , Sándor Pongor, Vasilis J. Promponas , Piotr Przymus , Julio Saez-Rodriguez, Alexia Sampri , Rajesh Shigdel , Blaz Stres , Ramona Suharoschi , Jaak Truu , Ciprian-Octavian Truică , Baiba Vilne, Dimitrios Vlachakis , Ercument Yilmaz , Georg Zeller , Aldert L. Zomer , David Gómez-Cabrero and Marcus J. Claesson

Perspective The human microbiome has emerged as a central research topic in human biology and biomedicine. Current microbiome studies generate high-throughput omics data across different body sites, populations, and life stages. Many of the challenges in ...

Published on 22 February 2021

Front. Microbiol. doi: 10.3389/fmicb.2021.635781

<https://www.frontiersin.org/articles/10.3389/fmicb.2021.635781/full>

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