ML4Microbiome for the advance of precisión medicine: What Biomedicine expects from us

Isabel Moreno-Indias, PhD

Department of Endocrinology and Nutrition, Virgen de la Victoria University Hospital, Institute of Biomedical Research in Malaga (IBIMA) and University of Malaga, Malaga, Spain

Centro de Investigación Biomédica en Red de la Fisiopatología de la Obesidad y Nutrición (CIBEROBN CB06/003), Instituto de Salud Carlos III, Madrid, Spain





The future of biomedicine





Collaboration required



Precision medicine combines medicine, biology, statistics, and computing. The most promising research in the field is characterized by sustained collaboration across disciplines and institutions.

For collaboration a common language and a common goal are needed











To base medical desicions on individual patient characteristics



Is this the best way to help to advance in precision medicine or is it only good for my particular research?

PRECISION MEDICINE promises multiple benefits

- Improved treatment efficacy
- Reduced adverse effects
- Lower costs for patients and providers
- Earlier diagnosis using biomarkers
- Improved prognosis estimation
- Smarter design of clinical trials

ML in precision medicine



Challenges for the perfect model in biomedicine





Insufficient prediction performance for clinical practice Garbage in, garbage out

The prediction performance of any ML model is limited by the descriptive power of the employed data with respect to the clinical endpoint of interest.

- Data is noisy: technical/biological?
- Discrimination between relevant and irrelevant patient-specificic features
- To obtain a sufficiently large patient cohort with well-defined phenotypes for training and testing models due to cost.
- Quantitatively and Objectively define clinical outcomes.
- Clinical outcomes can vary over time.
- Careful choice of patient samples



Difficulties in interpretation

ML models can discover patterns, but cannot prove causal relationships

Even if a model has an acceptable prediction performance, this model must be experimentally validated, because of the lack of a clear causal or mechanistic interpretation of ML model.

Interpreting the ML model

BLACK BOXIt is extremely important to know what is included in this black
box and understand the computational decision-making process
leading to the selection of specific predictors is mandatory



Model classes and model analysis



Validation and translation into clinical practice

Any ML algorithm requires rigorous validation to be used in clinical practice

Internal validation based on the initial Discovery cohort



External validation based on an independent cohort



Validation in a prospective clinical trial to demonstrate the benefit compared to standard care.



Data



Our personalized microbiomes reflect our lives



Individuals

Microbiome varies with disease conditions



How could ML help to microbiome science?



Microbiome, ML and precision medicine

Stratification of patients and development of biomarkers



LOW

Development of probiotic, prebiotic and microbiome targeting products to treat disease



To use this information to refine models

Take home messages

In order to advance in precision medicine with the use of machine learning and microbiome:

- There is a necessity of collaboration, and to make it possible, a common language and a common goal are needed.
- Interpretability of the models are mandatory and in this way, black box models must be avoided.
- Microbiome data adds individualized information to the models.



THANK YOU!! And if you have any question, please, ask or email me to Isabel.moreno@ibima.eu



