Heart Failure Prediction: Microbiome
FINRISK DREAM Challenge

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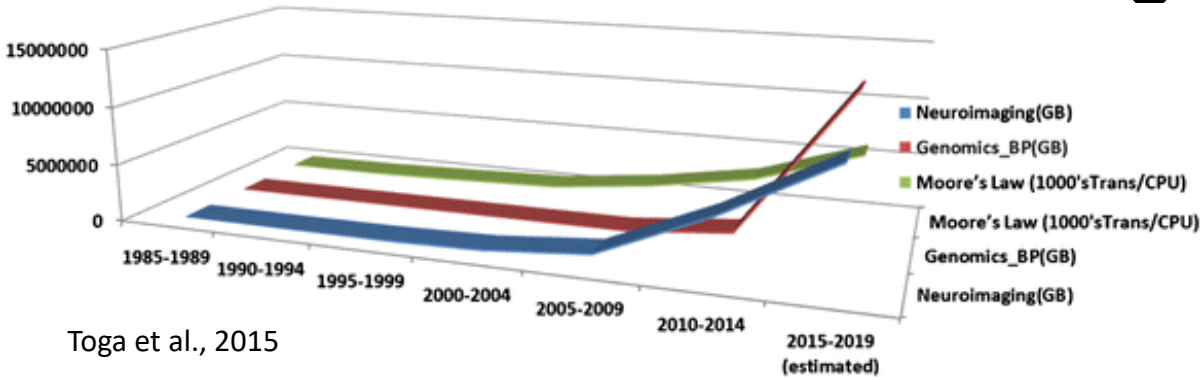
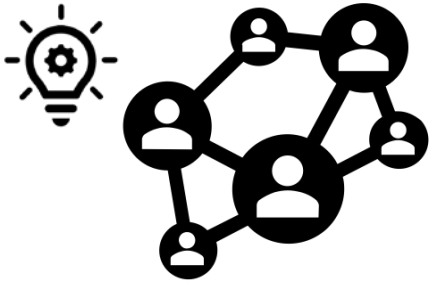
What motivates crowd-sourcing science?



Toga et al., 2015

Exponential growth of data in biomedical research

Growth goes beyond the capacity and expertise of individuals or classic research groups



joint effort of a large number of scientists with a diverse set of skills → accelerate discovery?

DREAM CHALLENGES
powered by Sage Bionetworks

Critical Assessment of Genome Interpretation

MICROBIOME
COMMUNITY OF SPECIAL INTEREST

kaggle

CASP15

Community challenge in biomedical research

DREAM CHALLENGES
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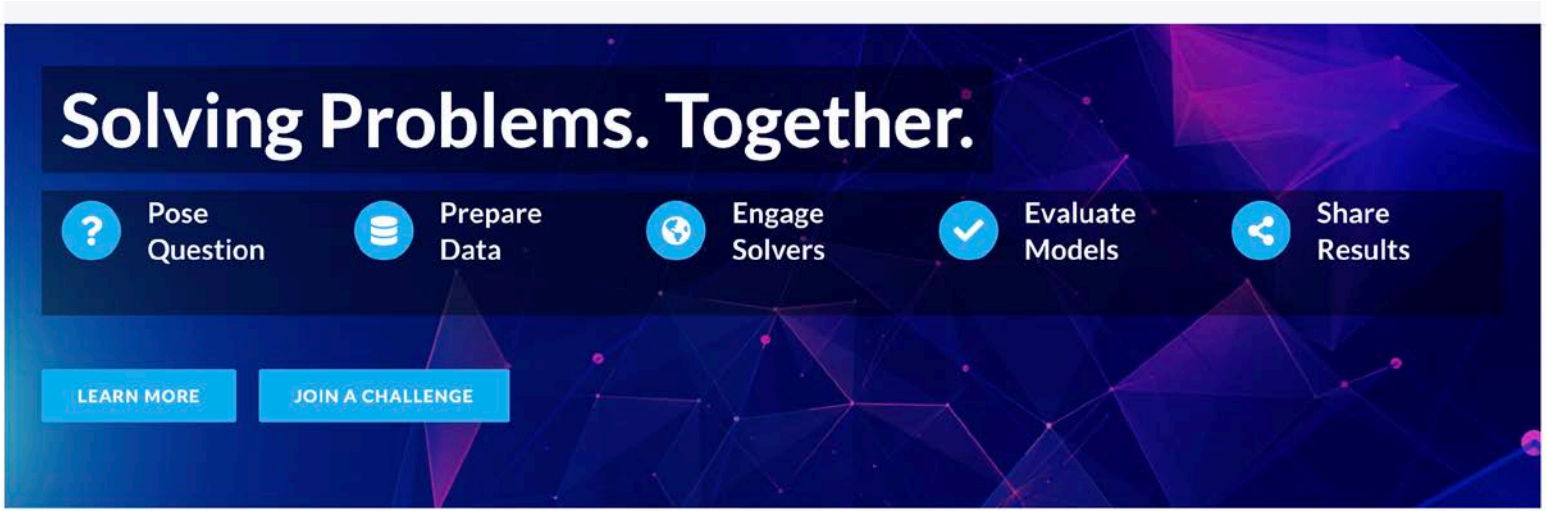
What is DREAM Challenge?



DREAM Challenges use crowd-sourcing to solve complex biomedical research questions

Open Challenges

COugh Diagnostic Algorithm for Tuberculosis (CODA TB) DREAM Challenge

By ambernelson | September 28, 2022 | Categories: Challenges, Infectious Disease, Open Challenge, Pre-Register

Register Tuberculosis (TB), a communicable disease

Heart Failure Prediction: Microbiome

By ambernelson | September 21, 2022 | Categories: Challenges, Open Challenge

Register Cardiovascular diseases are the leading cause of

Read More › 0

BraTS Continuous Evaluation

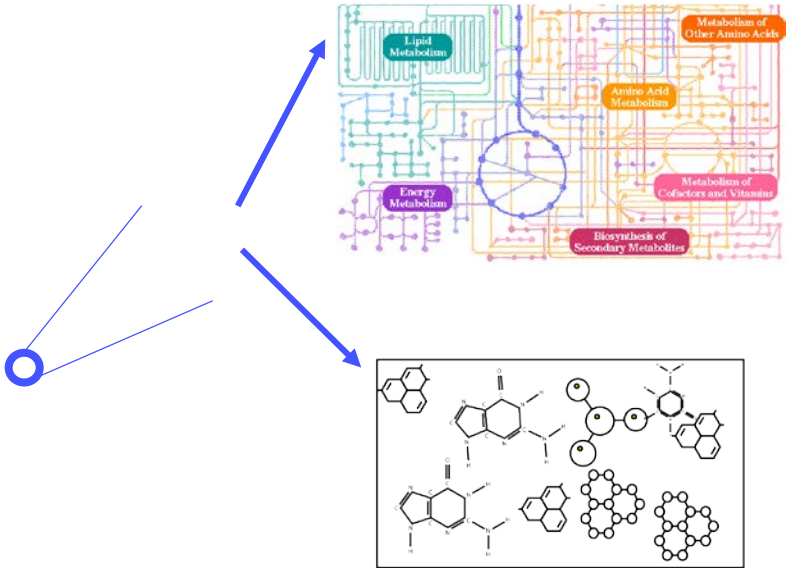
By ambernelson | June 6, 2022 | Categories: Cancer, Challenges, Open Challenge | Tags: Cancer

Register Brain tumors are among the deadliest types

Read More › 0

- More information: https://dreamchallenges.org/

Overview of human gut microbiome



Factors

- Diet
- Lifestyle
- Geography
- Age
- Medication
- Diseases
- Genetics

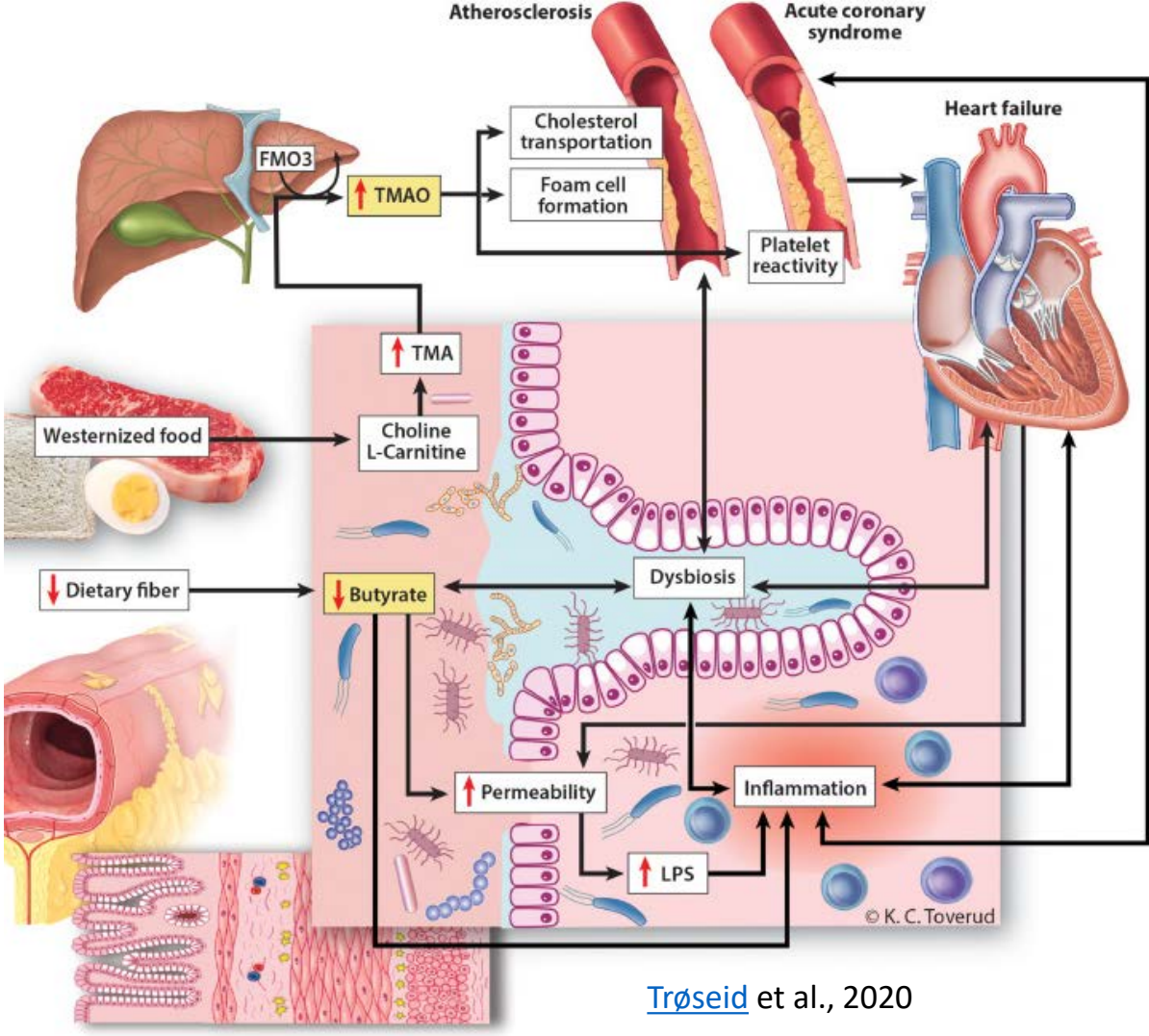
Roles

- Protecting host against pathogenic microbes
- Modulating immunity
- Regulating metabolic processes

Li et al., Nature Biotechnology, 2014, Human body picture designed by freepik.com

Can microbiome improve the predictions of heart failure?

- Heart failure remains difficult to diagnose due to the heterogeneity of the disease and a lack of agreement of diagnostic criteria
- The link between heart failure and the microbiome has long been postulated.
- Lack of study with temporal follow up



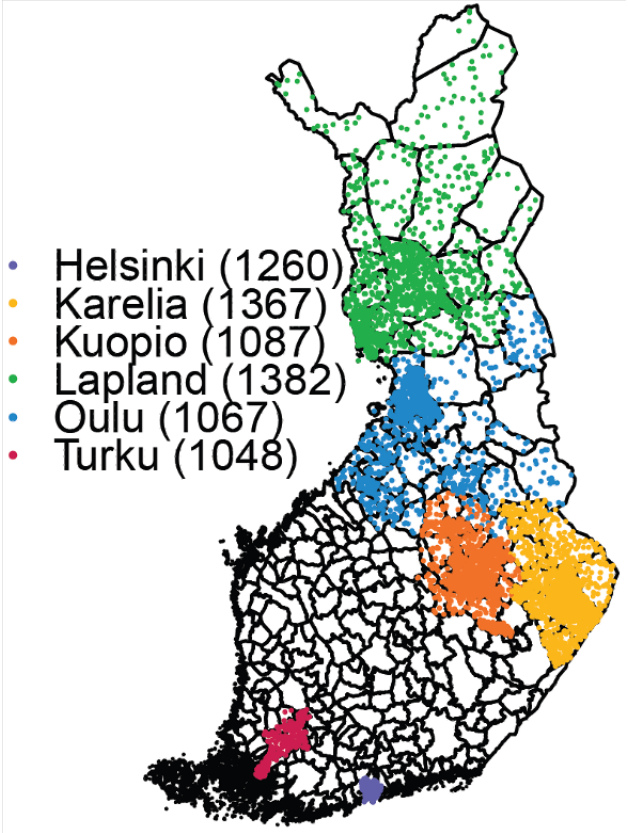
Trøseid et al., 2020

FINRISK 2002

13,498 invitees

↓

8,738 participated → 7,231 donated Fecal sample (54% participation rate) → DNA extractions And shallow metagenomic sequencing (~1M reads/sample)

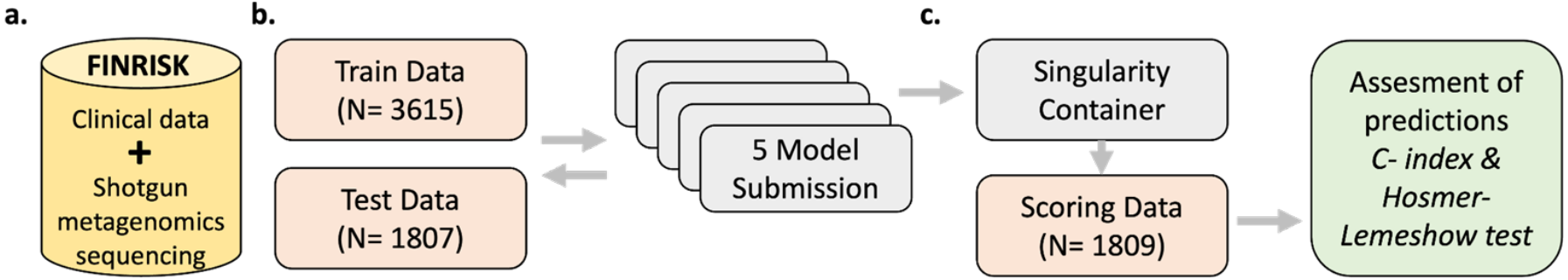


Participants were followed through for 15+ years.
There are **493 incident heart failure** among 6902 participants with complete phenotype

Borodulin et al., 2018

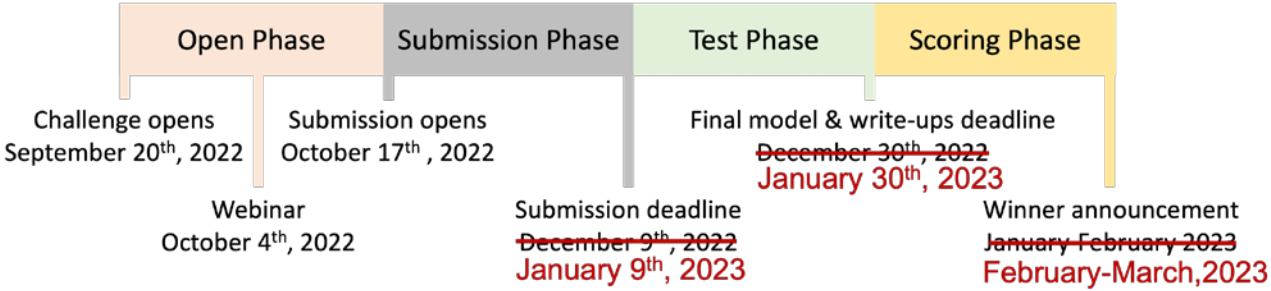
TASK: time-to-event predictions of the heart failure using a combination of the information from fecal microbiome composition and clinical data

FINRISK DREAM Challenge Workflow



Scan for more info

https://synapse.org/finrisk



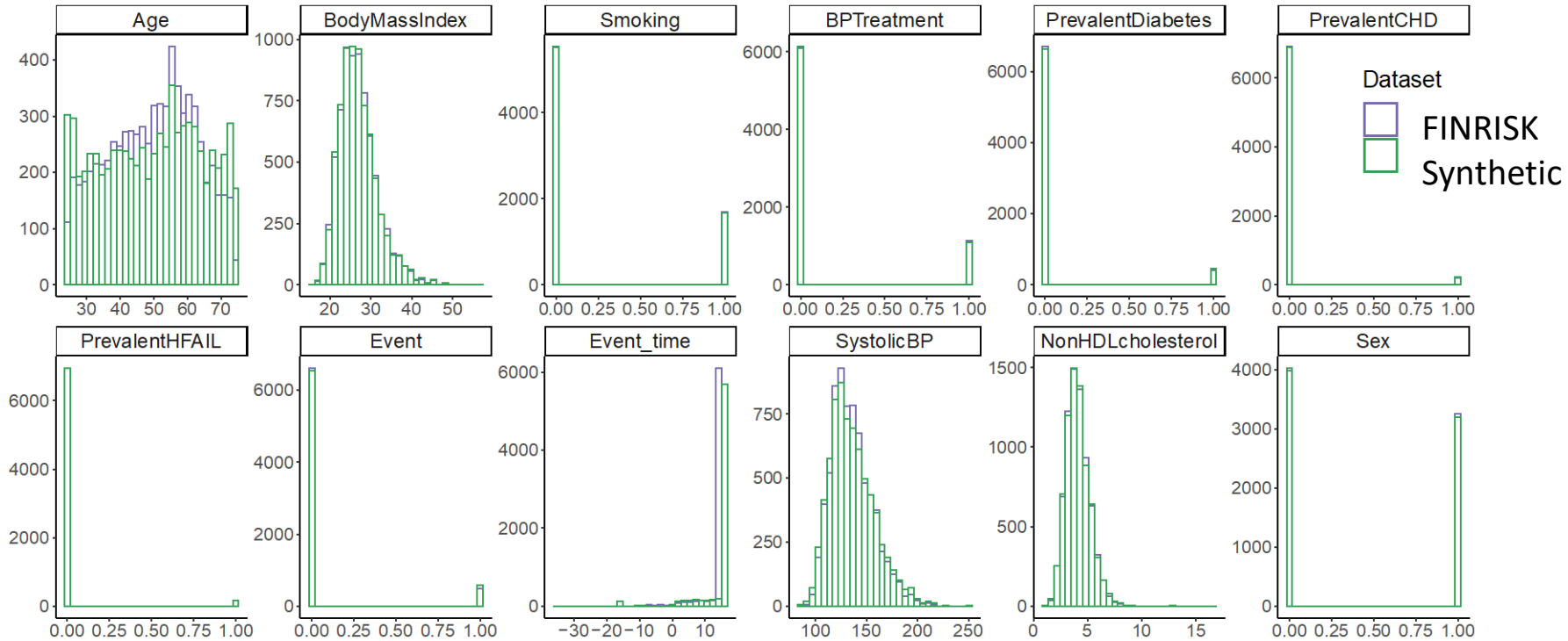
Synthetic data generation: Why is it necessary?

IMPORTANT! The FINRISK data contains sensitive personal information from healthcare registers which cannot be shared **without formal agreement with THL biobank**

Criteria: preserve the covariance structure while privatizing the data

Rank-based Inverse Normal Transformation (by Aki Havulinna, 2022)

Synthetic vs Real data on clinical covariates

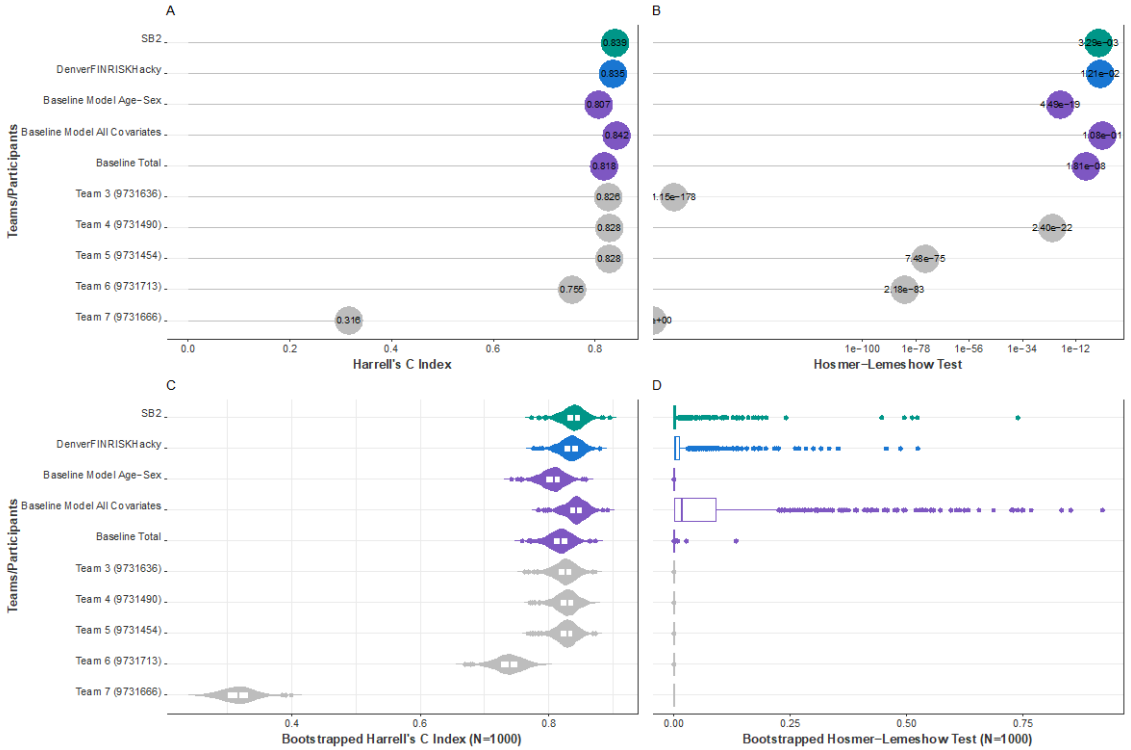


Received submissions

- 35 VALID submissions from 9 participants were accepted in submission phase
- 7 teams submitted final model

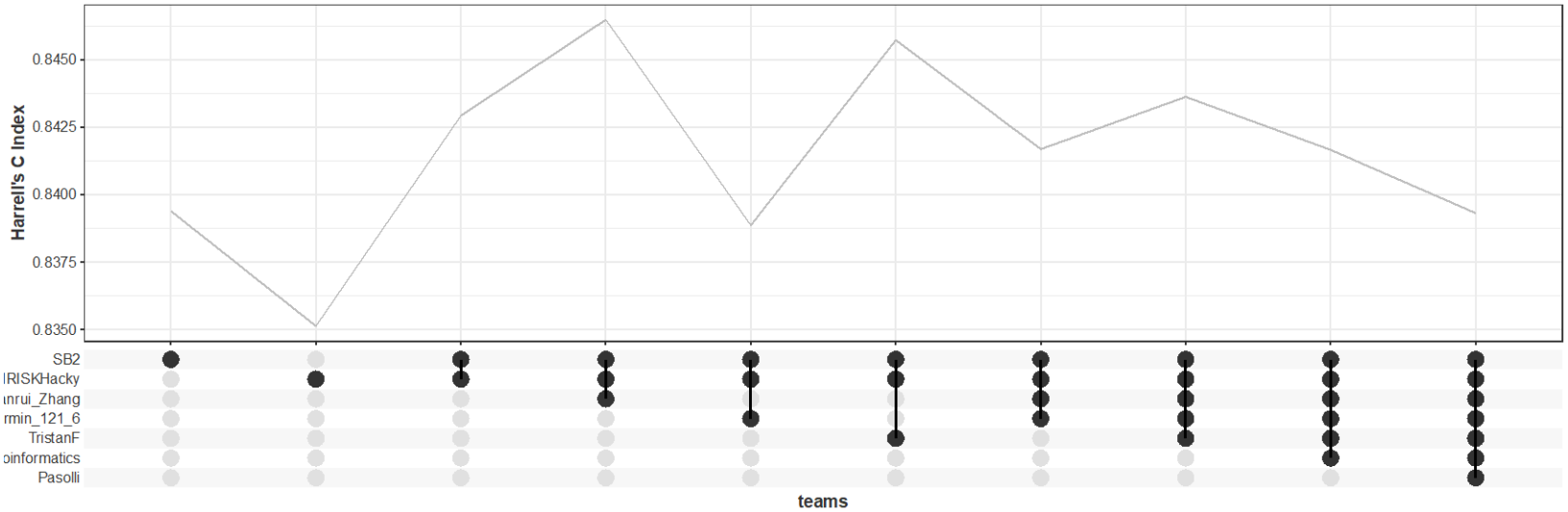
id	createdOn	submitterid	status	harrell_c	hoslem_test
9731637	1/29/2023 11:29 PM	SB2	SCORED	0.839395379197954	0.0032924949185753
9731625	1/29/2023 7:12 PM	DenverFINRISKHacky	SCORED	0.835136923343354	0.0120891360271361
9731490	1/27/2023 1:26 AM		SCORED	0.827974369335565	2.40190686358651e-22
9731454	1/26/2023 11:55 AM		SCORED	0.827752343482875	7.48389464769304e-75
9731636	1/29/2023 11:02 PM		SCORED	0.825842921149739	1.14999761860238e-178
9731713	1/31/2023 12:33 AM		SCORED	0.754830172425277	2.18334641086665e-83
9731666	1/30/2023 9:35 PM		SCORED	0.315609749599243	0

Received model performance vs Baseline model

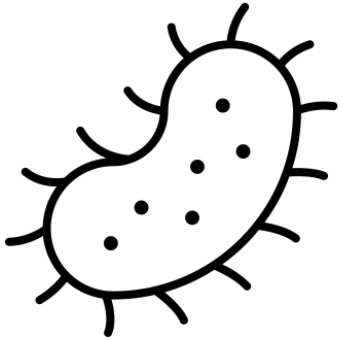


Post Challenge Phase

- Model refinement from each winning team
- Extract knowledge through “wisdom of the crowd” approach by assessing the ensemble model performance
- Investigating the most predictive features to discuss the clinical relevancy of the model



Perspective of the challenge



- Open avenue to explore the potential of microbiome-based biomarkers to complement clinical risk factors in identifying individuals with an elevated risk of Heart Failure.
- The crowdsourced *Challenge* provides a unique platform for solving scientific problem.
- The synthetic dataset has proven beneficial for challenge participants and could become an option for data sharing while ensuring privacy protection.

Acknowledgements

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