Enhancing prognostic precision in Acute Lymphoblastic Leukemia: a synergy of Topological Data Analysis and Artificial Intelligence

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Abstract: Despite advancements in treatment, a subset of patients with acute lymphoblastic leukaemia (ALL) faces relapse, highlighting the need for improved prognostic tools. Traditional risk assessment methods rely on manual interpretation of flow cytometry data, which may overlook subtle but significant patterns. In this talk, we present a novel approach integrating topological data analysis (TDA) and machine learning (ML) to analyze pre-treatment ALL datasets [1]. By quantifying shapes, including empty spaces, in the high-dimensional flow cytometry data, our method accurately predicts the risk of relapse, particularly in patients previously classified as 'low risk'. Additionally, we validate the predictive power of specific biomarkers such as CD10, CD20, CD38, and CD45. We propose three prognostic pipelines of increasing complexity, offering tailored approaches depending on technical availability. Our findings extend beyond ALL, demonstrating the potential of TDA and ML in enhancing risk stratification in haematological malignancies.

References:

[1] Salvador Chulián, Bernadette J Stolz, Álvaro Martínez-Rubio, Cristina Blázquez Goñi, Juan F Rodríguez Gutiérrez, Teresa Caballero Velázquez et al. The shape of cancer relapse: Topological data analysis predicts recurrence in paediatric acute lymphoblastic leukaemia. PLOS Computational Biology 19(8): e1011329. DOI: 10.1371/journal.pcbi.1011329