Heinrich Heine Universität Düsseldorf

Manchot Forschungsgruppe
Entscheidungsfindung mit Hilfe von Methoden der Künstlichen Intelligenz

A cooperation between Use Case Economy and Use Case Health

Explainable Mortality Prediction in Allogeneic Stem Cell Transplantation

Problem: Estimate individual mortality risk after Allo-SCT, a potentially curative but high risk thearapy for hematologic deceases.
Current Solutions: Static scores and ML models for predominant mortality risk prediction for a fixed interval without adaptation to changing health status.
Our Solution: AI based system that monitors seven-day mortality risk based on progression of basic blood parameters from the last 14 days. It is able to differentiate low- and high risk patients.
Application: Enable physicians to monitor mortality risk on a daily basis and allocate healthcare resources.

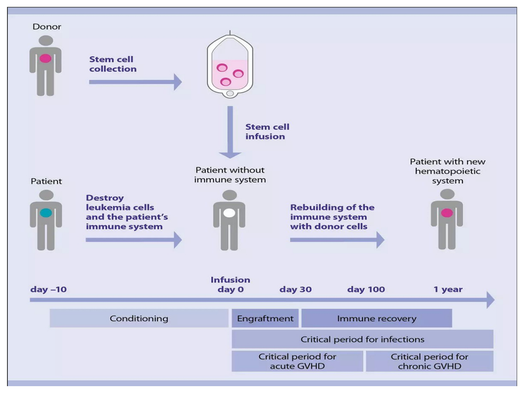
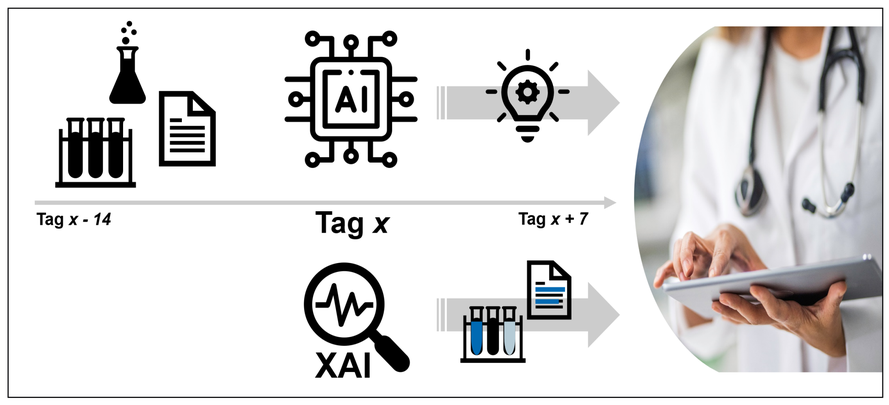
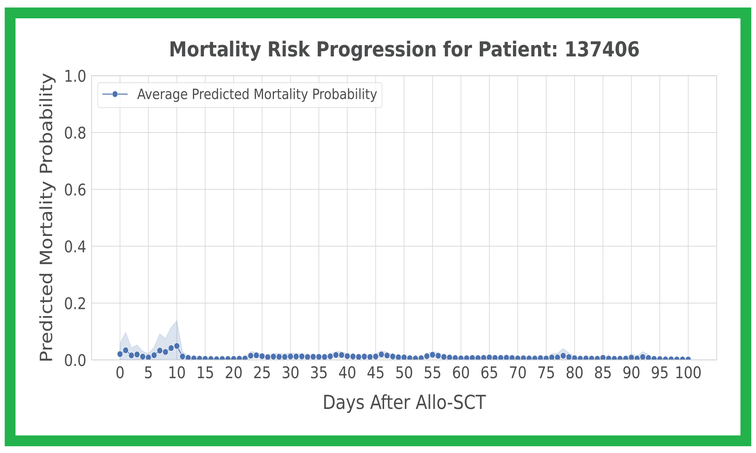
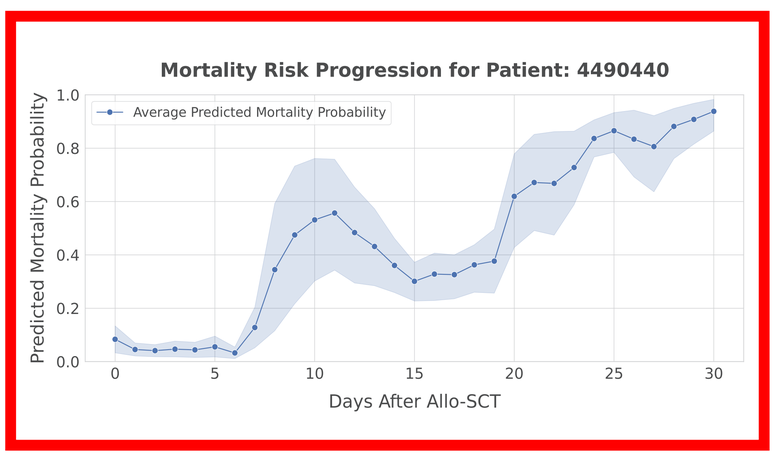


Image taken from [1]







Data

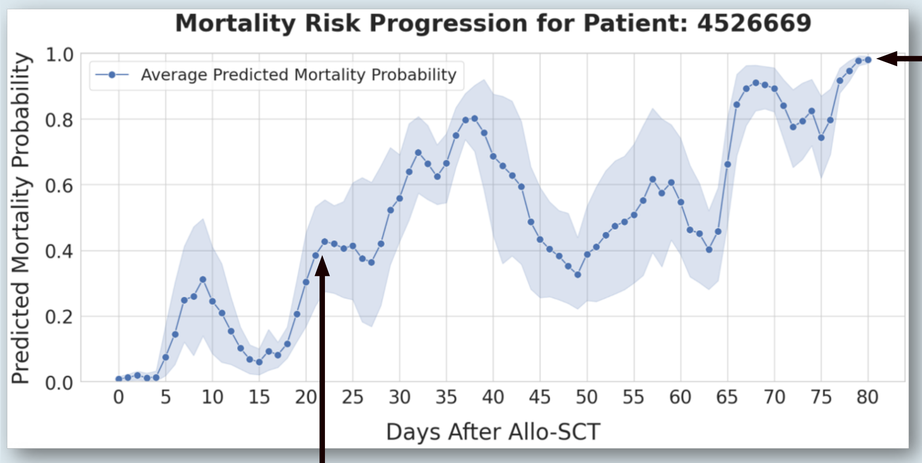
Historical medical records from 931 patients who underwent Allo-SCT at UKD between 2004 and 2019.

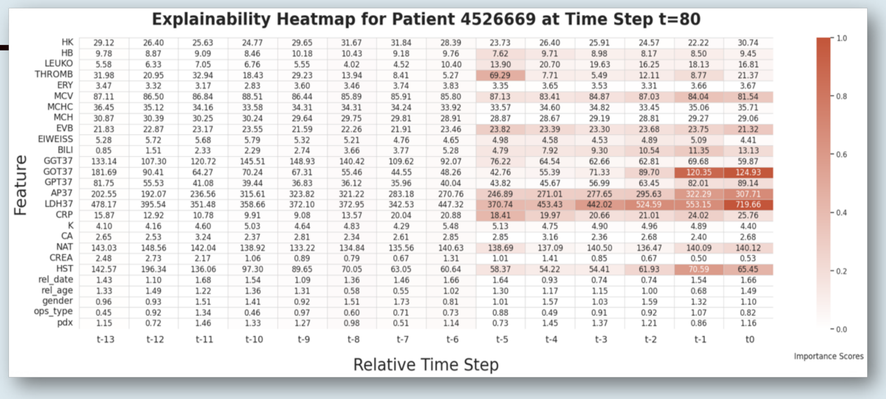
Methodology

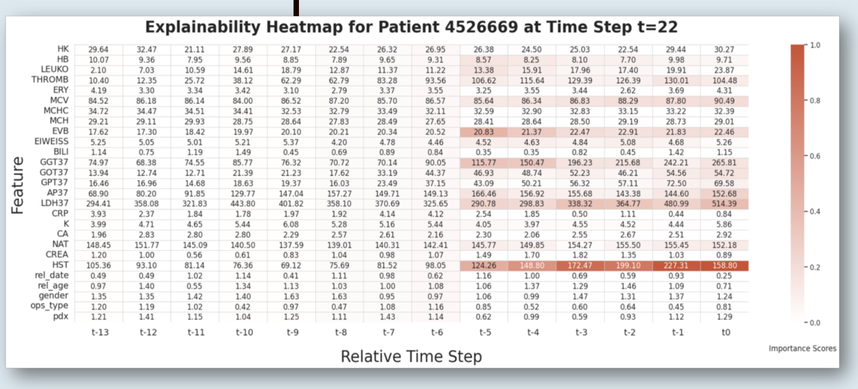
Combination of XCM [2](eXplainable Convolutional Network for Multivariate time series classification) for mortality risk prediction and Integrated Gradients [3] (IG) with Temporal Saliency Rescaling [4](TSR) for explanations.

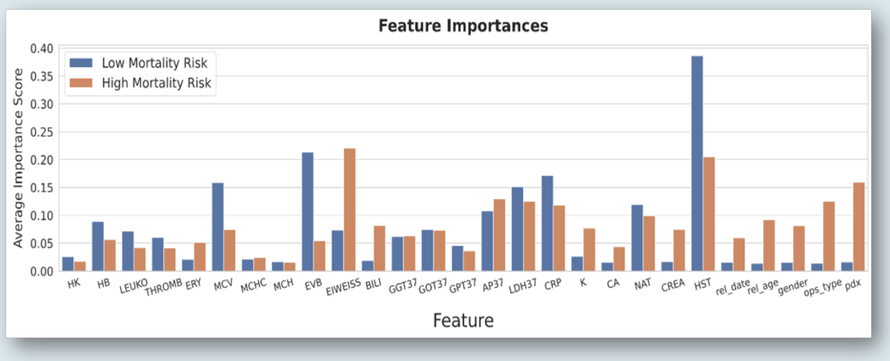
Results

High discrimination of patients by observing high and volatile seven-day mortality risk scores. IG+TSR allow to obtain individualized, context- and time sensitive explanations for each prediction. The aggregation of explanations enables the provision of individualized feature importances. Aggregations of populations and patients provide different views. Explanations are interpretable by a non-technical user!





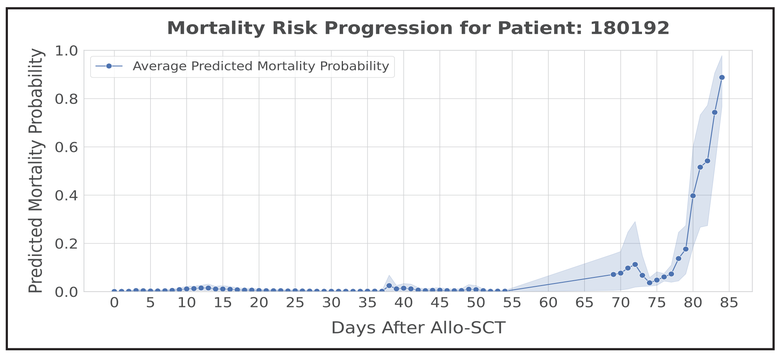




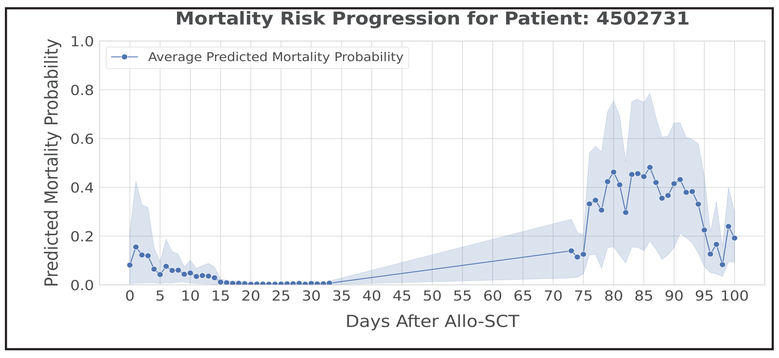
Additional Interesting Results

The models correlate deteriorating health status with imminent risk of mortality, regardless of the patient‘s admission status, offering potential for early intervention.For example, our solution identified three out of eight patients who died outside of intensive care unit as high-risk patients before their death.

Example 1: High mortality risk for stationary patient. This patient deceased at day 85 but was never admitted to intensive care.



Example 2: High mortality risk for outpatient patient. This patient is readmitted afterwards.



[1] M. Biotec, “What is allogeneic stem cell transplantation? tients | pa | cell therapy | products | miltenyi biotec | deutschland.” [Online] [2] K. Fauvel, T. Lin, V. Masson, E. Fromont, and A. Termier, “Xcm: An explainable convolutional neural network for multivariate time series classification,” Mathematics, vol. 9, no. 23, p. 3137, Dec. 2021. [Online]. Available: http://dx.doi.org/10.3390/math9233137 [3] M. Sundararajan, A. Taly, and Q. Yan, „Axiomatic attribution for deep networks,“ 2017 [4] A. A. Ismail, M. Gunady, H. C. Bravo, and S. Feizi, “Benchmarking deep learning interpretability in time series predictions,” 2020.

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