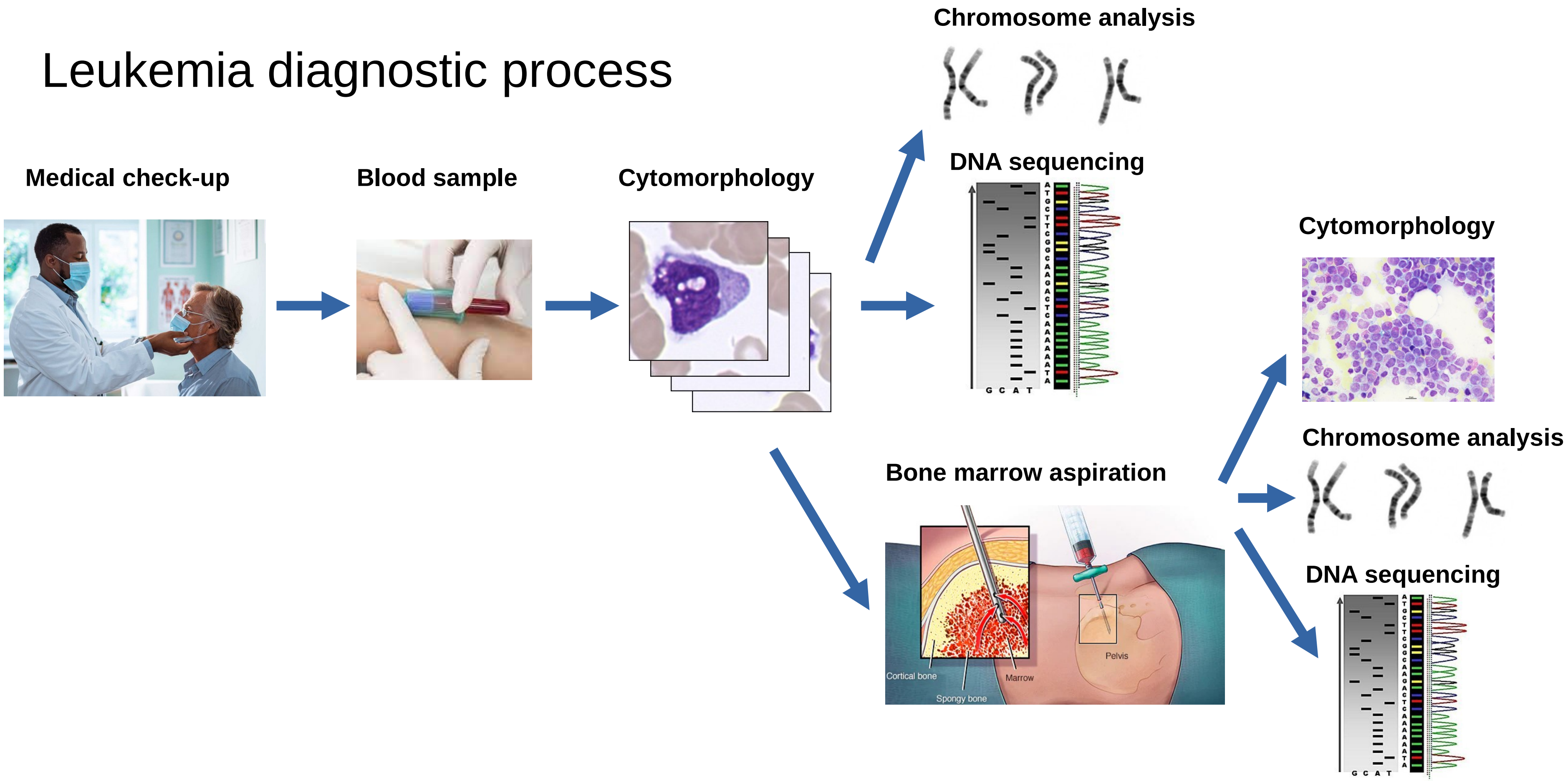
HELMHOLTZ
MUNICH

Attention based multiple instance learning for the real-world scenario leukemia diagnosis

Ivan Kukuljan
Helmholtz Zentrum Munich, Institute of AI for health

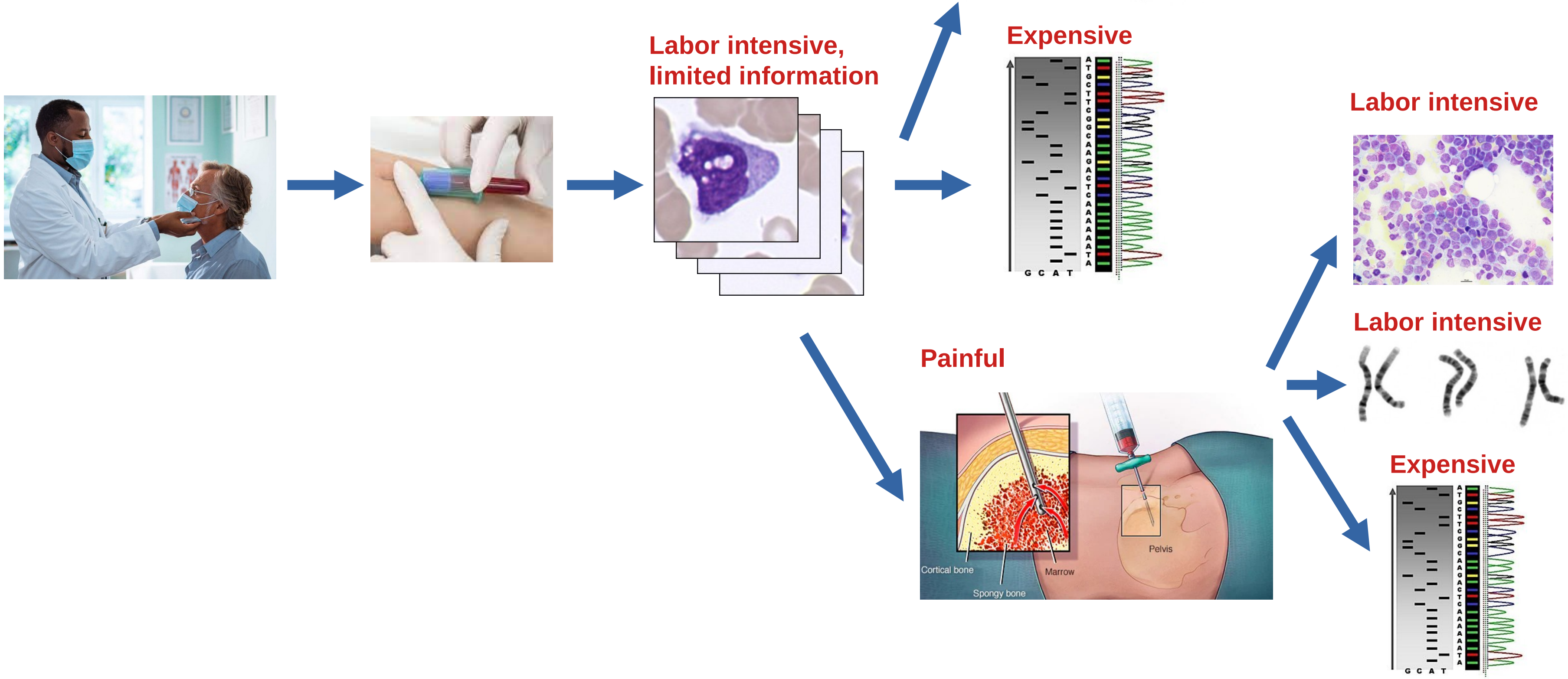
Helmholtz AI Conference 2023, June 13, 2023

Leukemia diagnostic process



HELMHOLTZ MUNICH

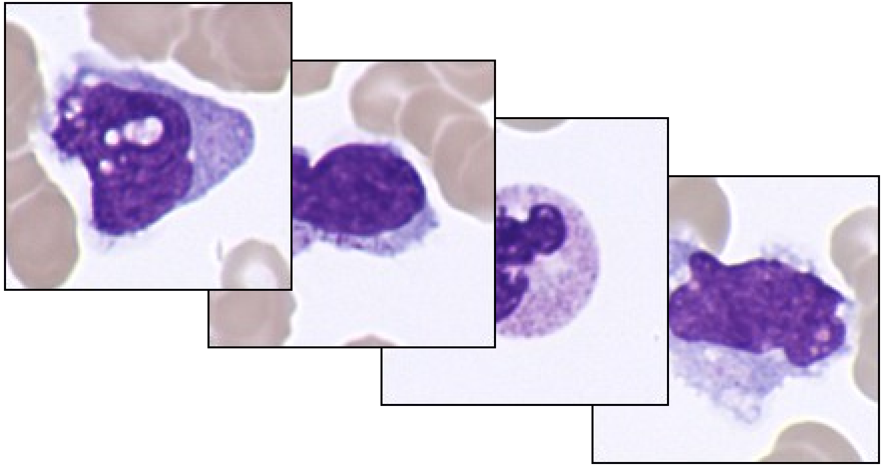
Leukemia diagnostic process



HELMHOLTZ MUNICH

MLL Beluga data set

- 6757 patients + 495 healthy controls
- 160 different diagnoses
- Several modalities available, currently training on peripheral blood smears
- 500 single cell images per patient (over 3 mio images!)
- Label only on the patient level



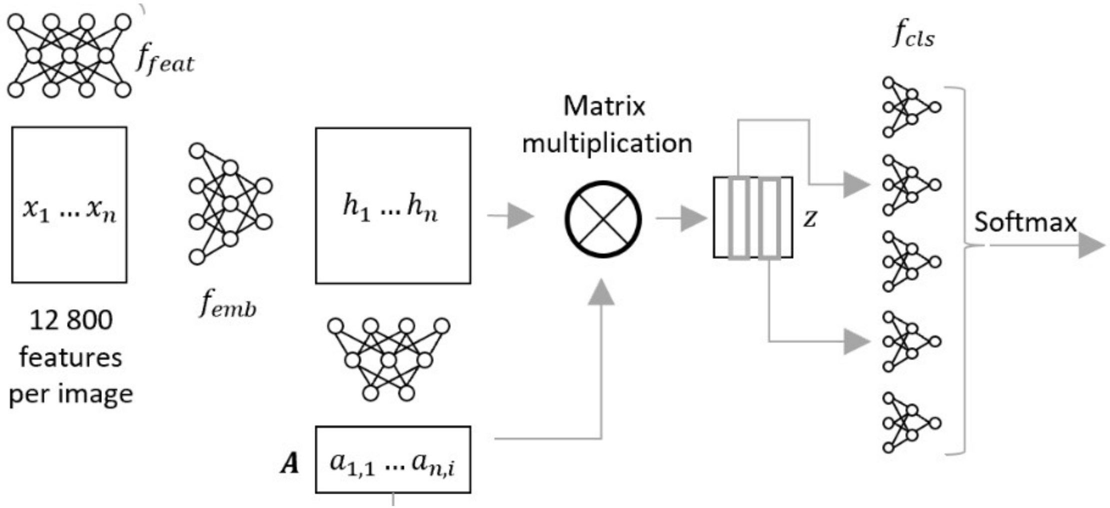
Attention based multiple instance learning

Sadafi, A. et al. (2020). Attention Based Multiple Instance Learning for Classification of Blood Cell Disorders. In: , et al. Medical Image Computing and Computer Assisted Intervention – MICCAI 2020. MICCAI 2020. Lecture Notes in Computer Science(), vol 12265. Springer, Cham.

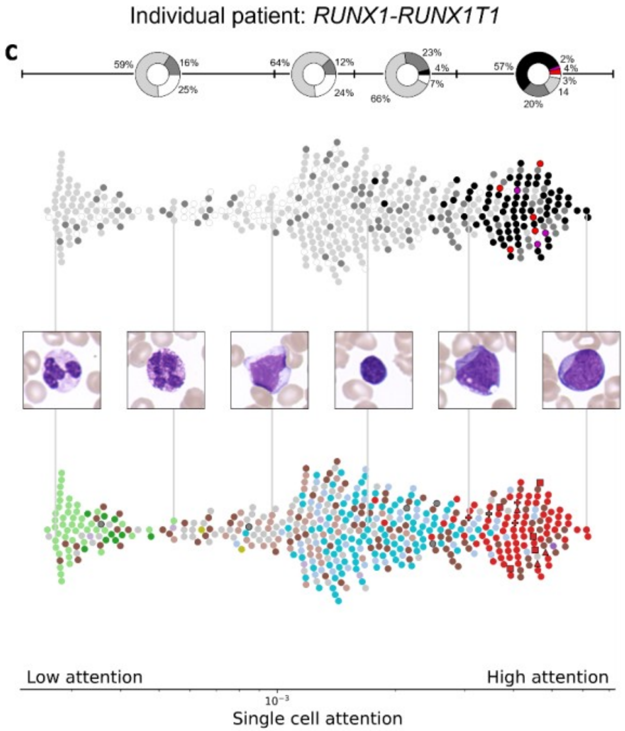
Hehr, M. et al. (2023). Explainable AI identifies diagnostic cells of genetic AML subtypes. PLOS digital health. 2. e0000187. 10.1371/journal.pdig.0000187.

$$z = \sum_{k=1}^{N} A_{i,k} h_k , \forall c_i \in C$$

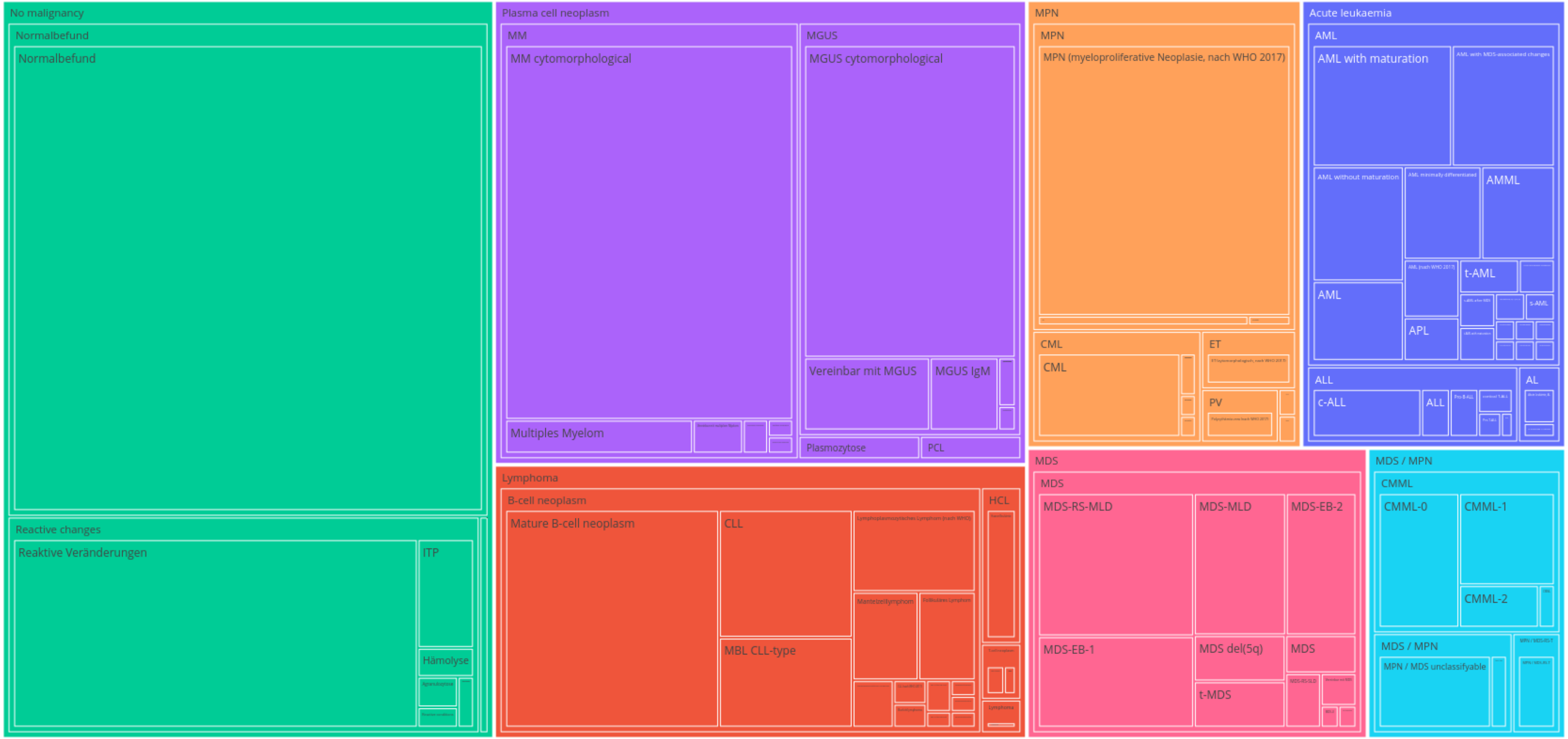
$$\alpha_{i,k} = \frac{\exp\{W^T \tanh(V_i h^T_k)\}}{\sum_{j=1}^{N} \exp\{W_i^T \tanh(V_i h_k\}}, \forall c_i \in C$$



The model successfully identifies relevant cells

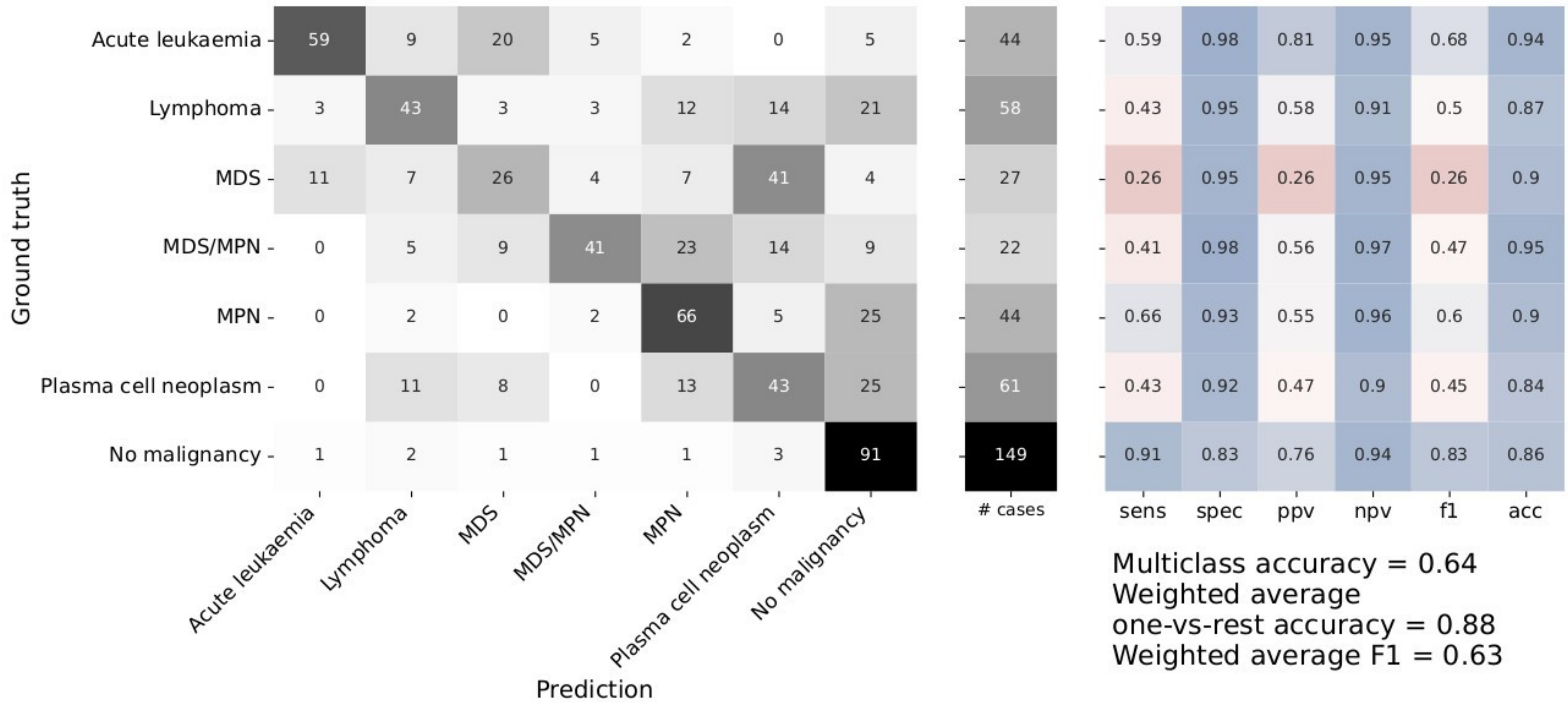


Performance in the real world scenario

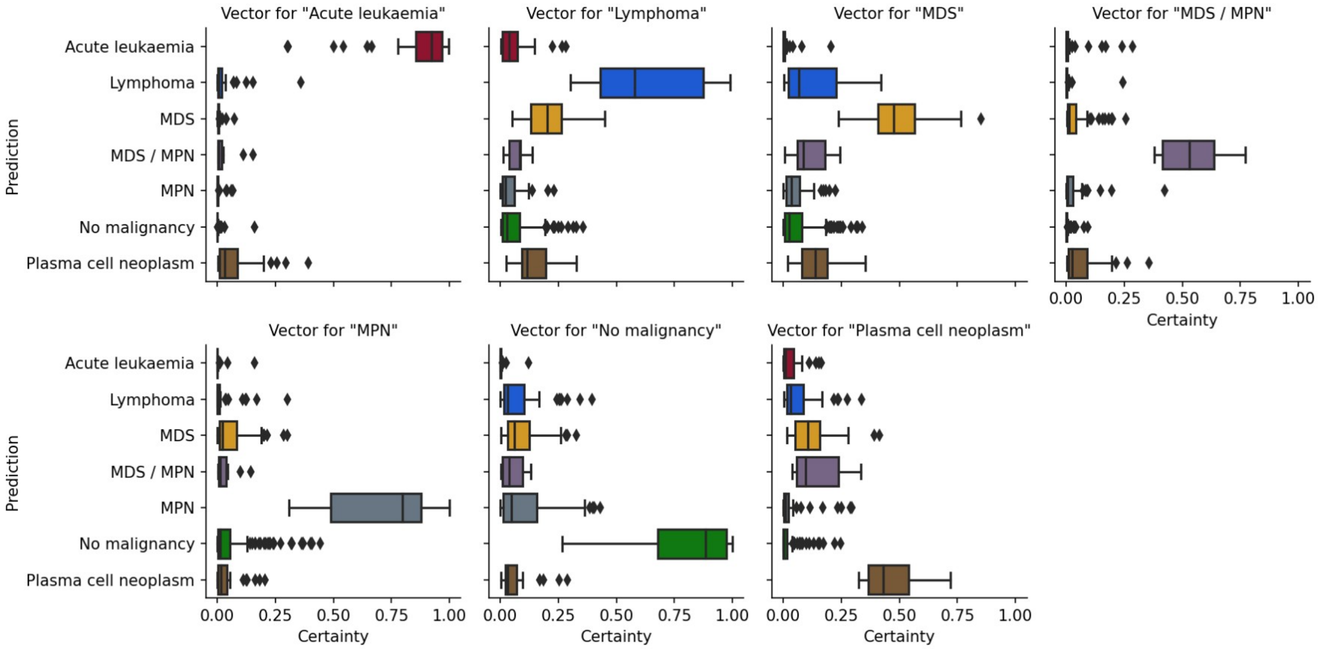


HELMHOLTZ MUNICH

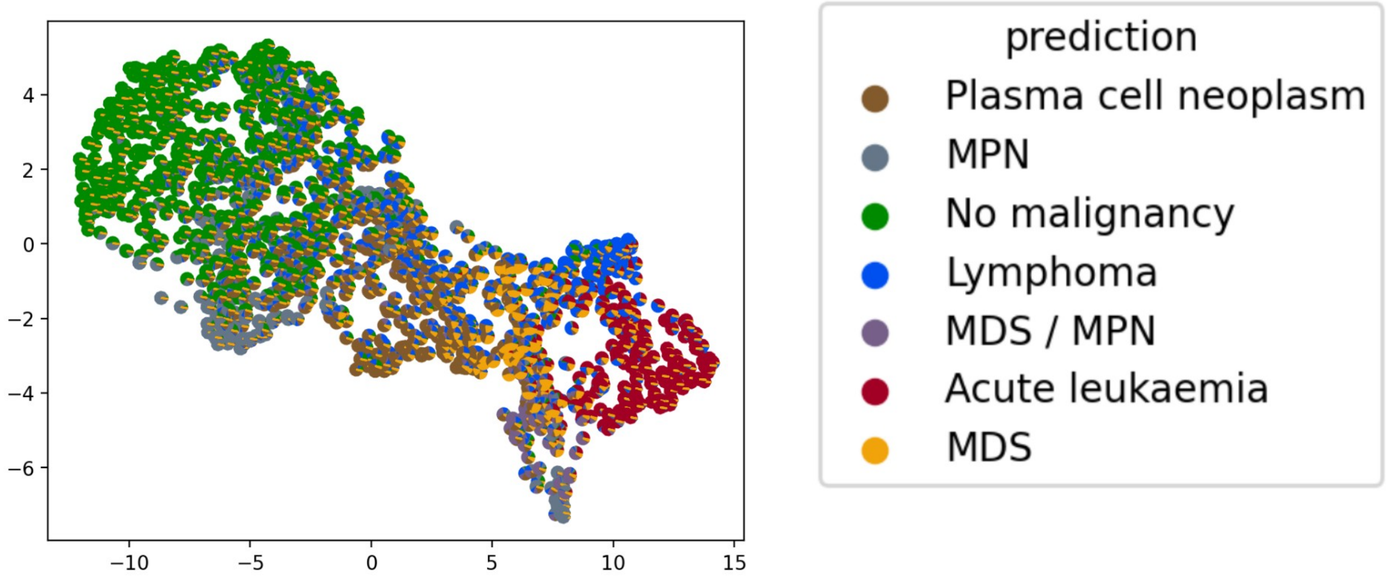
Performance in the real world scenario



Prediction probabilities

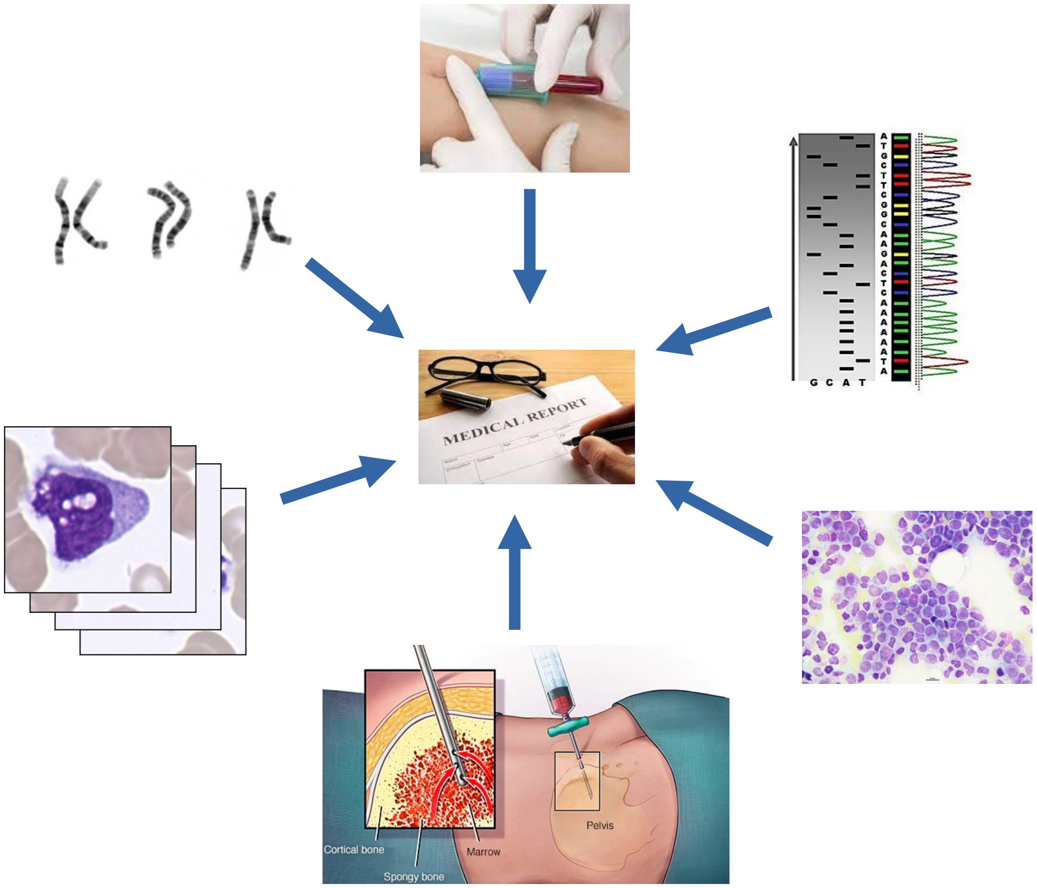


Patient embedding



Future research directions

- Self supervised learning
- Full multi modal leukemia diagnostics
- Implementation in the diagnostic procedure in the MLL



Coworkers

Peter Lienemann

Medical Faculty, LMU Munich and Helmholtz Zentrum Munich

Marton Kanasz-Nagy

MPI for Quantum Optics

Matthias Hehr

LMU Munich and Helmholtz Zentrum Munich

Ario Sadafi

TUM and Helmholtz Zentrum Munich

Carsten Marr

Helmholtz Zentrum Munich

Christian Pohlkamp

Munich Leukemia Laboratory