Fairness and Transportability in AI Models for Survival Analysis

Joseph Vento, MD, MS[1]; Luca Bonomi PhD[2]

[1]Dept. Internal Medicine UT Southwestern, Dallas; [2]Dept. Biomedical Informatics, VUMC, Nashville

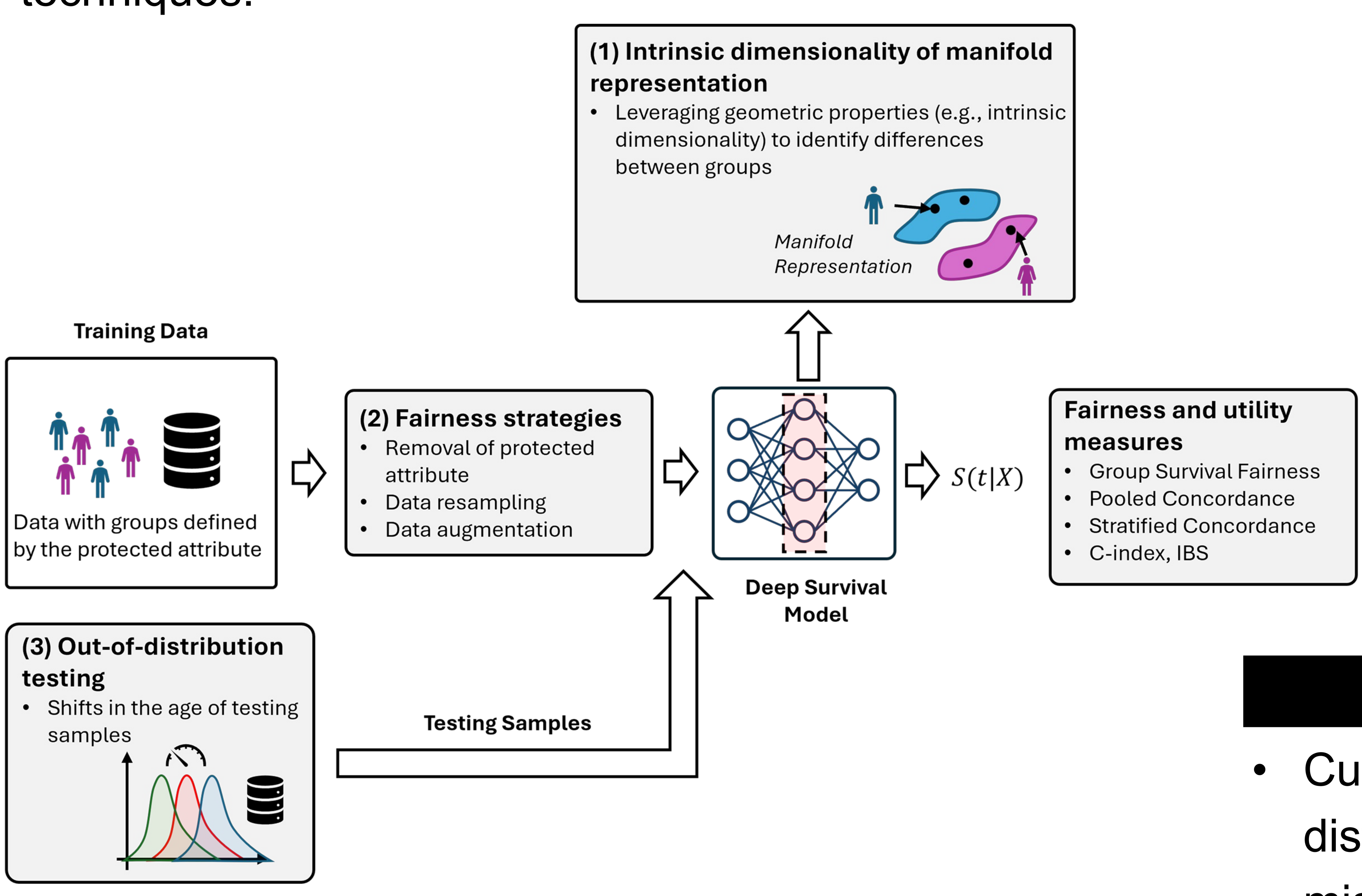
Introduction

- Deep learning models struggle in the presence of data distribution shifts (e.g., out-of-distribution).
- Increased risks of unfair predictions and disparities in health outcomes across patient groups.

Methods

We study state-of-the-art deep survival models: DeepSurv[1], DeepHit[2], NneSurv[3].

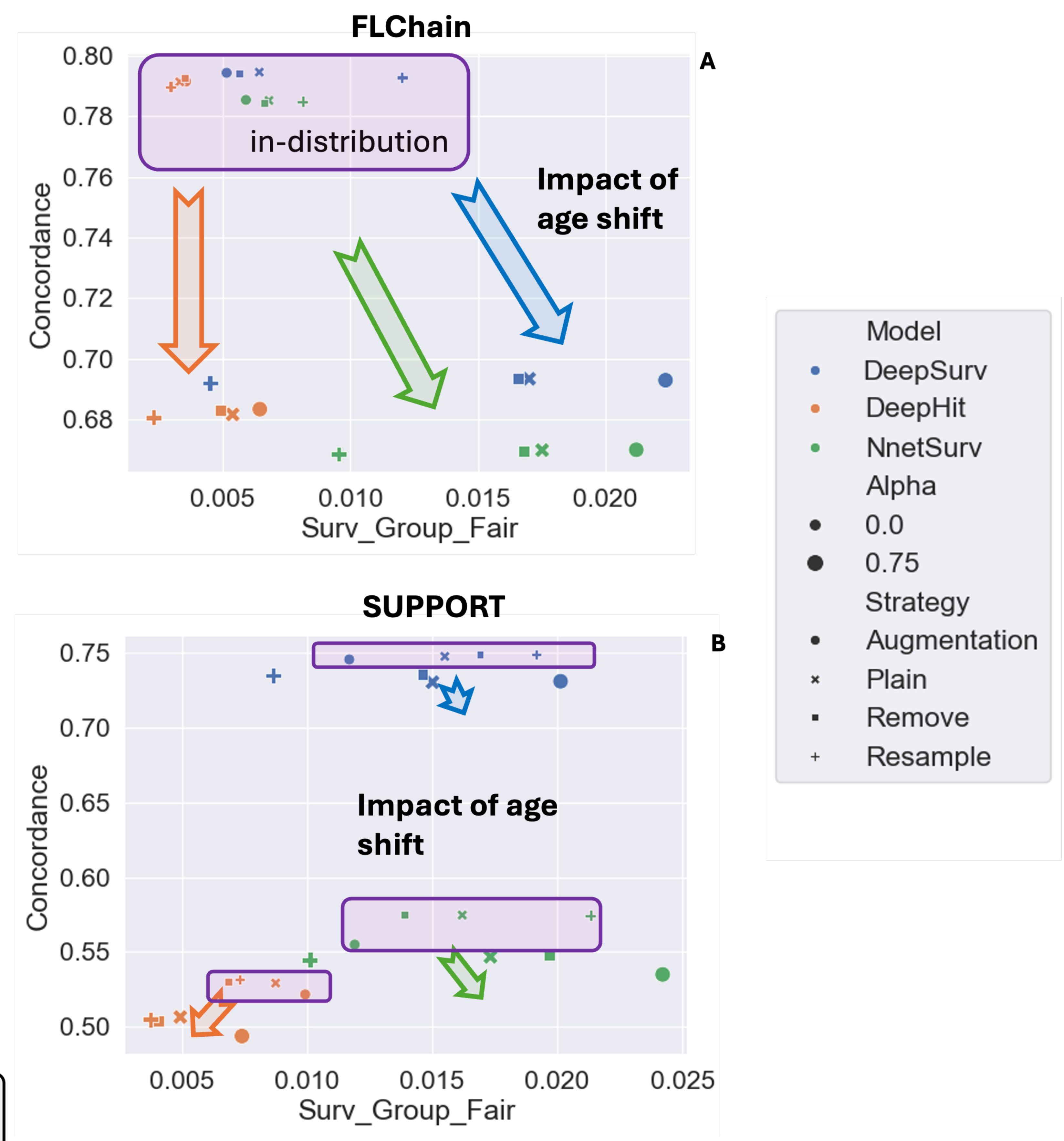
We analyze how out-of-distribution data impact manifold representations, utility, and fairness in original models and those trained with fairness-aware techniques.



Results

Datasets: FLChain,[4] SUPPORT[5]

- Difference in complexity of the manifold representation for different protected attributes (e.g., race vs. gender).
- Positive correlation between the intrinsic dimensionality and fairness: Pearson's correlation coefficient >0.38 with p-value<0.0001.
- >10% loss in C-index in the presence of shifts.
- Fairness-aware learning strategies result in unexpected behaviors (e.g., worse fairness than the original model) for out-of-distribution samples.



Discussion

- Current approaches are designed under an in-distribution assumption, resulting in models misbehaving in the presence of out-of-distribution samples.
- Consider a host of intersecting factors to improve model transportability and performance for all patients.

Citations

1. Katzman JL, Shaham U, Cloninger A, Bates J, Jiang T, Kluger Y. DeepSurv: personalized treatment recommender system using a Cox proportional hazards deep neural network. BMC Med Res Methods. 2018;18(1):24. doi:10.1186/s12874-018-0482-1
2. Lee C, Yoon J, Schaar M van der. Dynamic-DeepHit: A Deep Learning Approach for Dynamic Survival Analysis With Competing Risks Based on Longitudinal Data. IEEE Trans Biomed Eng. 2020;67(1):122-133. doi:10.1109/TBME.2019.2909027
3. Zhao L, Feng D. Deep Neural Networks for Survival Analysis Using Pseudo Values. IEEE J Biomed Health Inform. 2020;24(11):3308-3314. doi:10.1109/JBHI.2020.2980204
4. Dispenzieri A, Katzmann JA, Kyle RA, et al. Use of nonclonal serum immunoglobulin free light chains to predict overall survival in the general population. Mayo Clin Proc. 2012;87(6):517-523
5. Knaus WA, Harrell FE, Lynn J, et al. The SUPPORT prognostic model. Objective estimates of survival for seriously ill hospitalized adults. Study to understand prognoses and preferences for outcomes and risks of treatments. Ann Intern Med. 1995;122(3):191-203.

UTSouthwestern Medical Center
Clinical Informatics Center

VANDERBILT UNIVERSITY MEDICAL CENTER
Department of Biomedical Informatics

ACKNOWLEDGEMENT: R00HG010493, R01LM013712, and T15LM007450

luca.bonomi@vumc.org