Unsupervised learning of aging principles from longitudinal data

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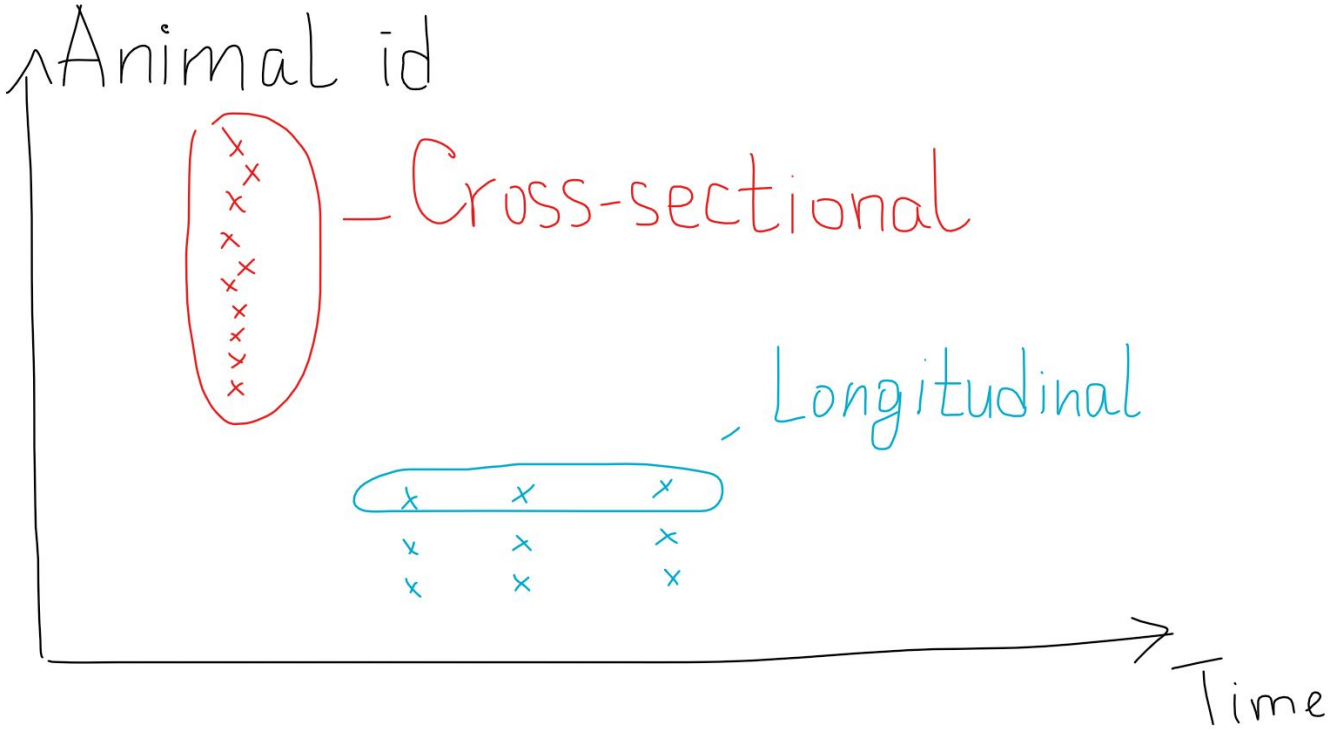
Introduction

Biomarker of aging is a measurable characteristic of a living creature, which predicts longevity and future functional capacity better, then chronological age.

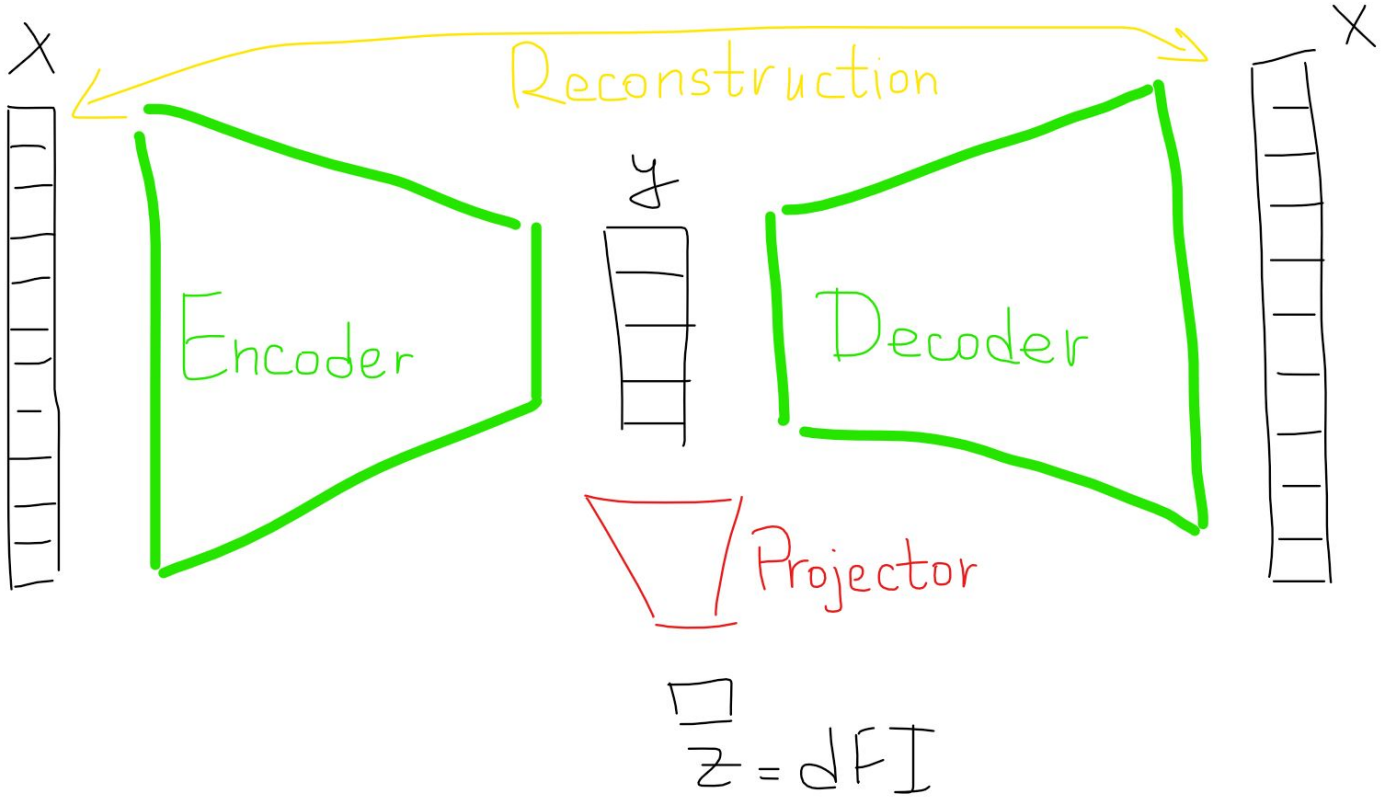
Authors of considered paper find new biomarker of aging — dynamic Frailty Index (dFI)

- Correlates well with existing ones
- Has the benefit of being computed from easily measurable blood parameters
- Found by analyzing a number of cross-sectional and longitudinal datasets

Datasets



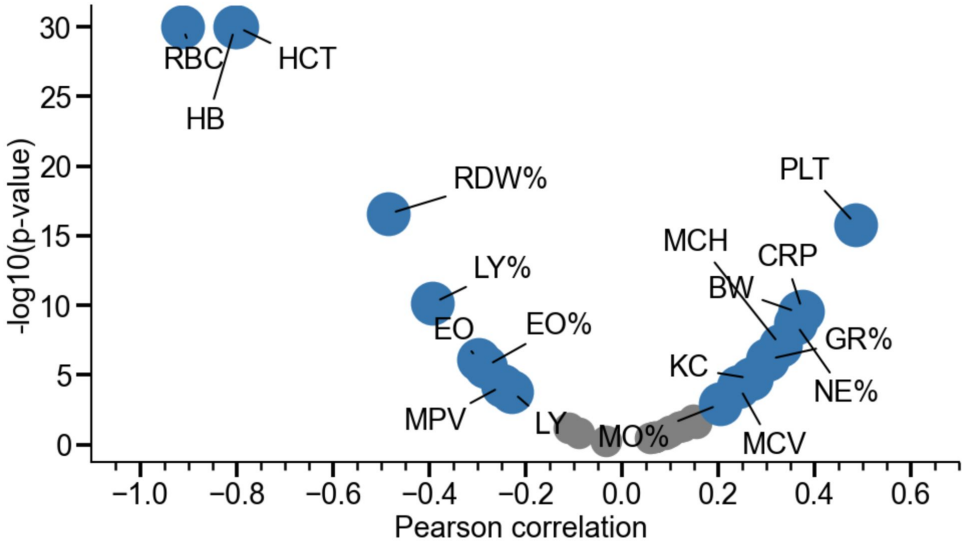
Autoencoder



Results

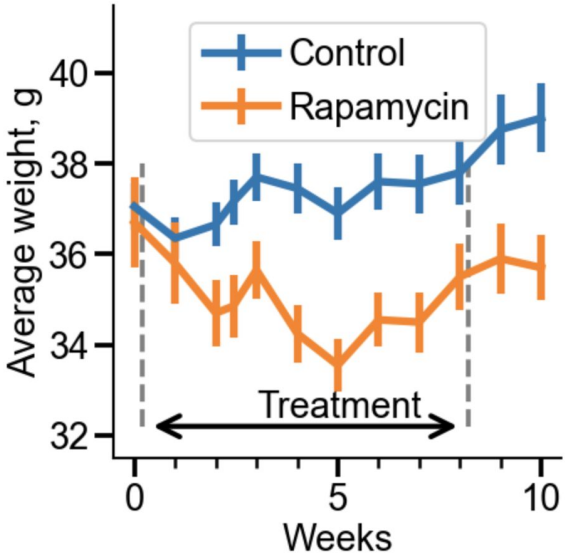
Aging biomarkers:

- PFI (physiological frailty index),
- RDW (red blood cell distribution width),
- BW (body weight),
- C-reactive protein,
- murine chemokine CXCL1,
- total luciferase flux

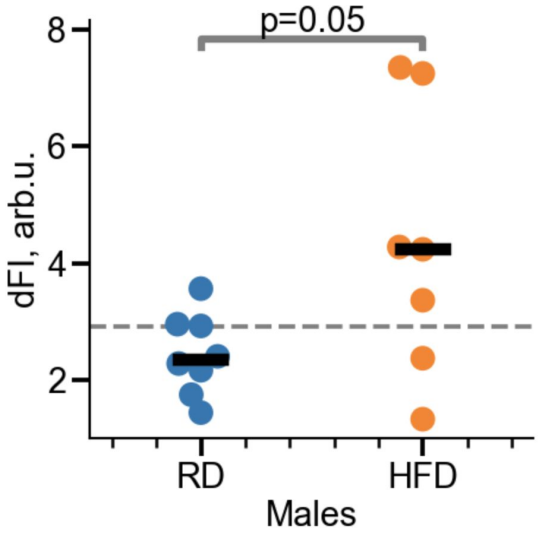


Volcano plot representation of the dFI correlation with the extended set of biomarkers

dFI reflects lifespan-modulating interventions

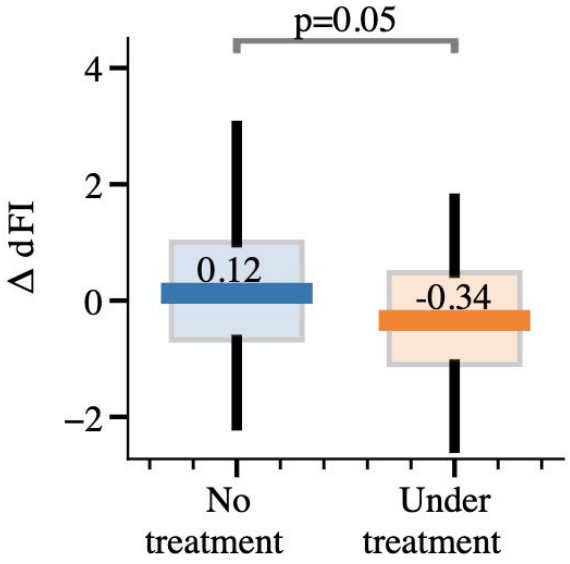


Rapamycin treatment decreases dFI

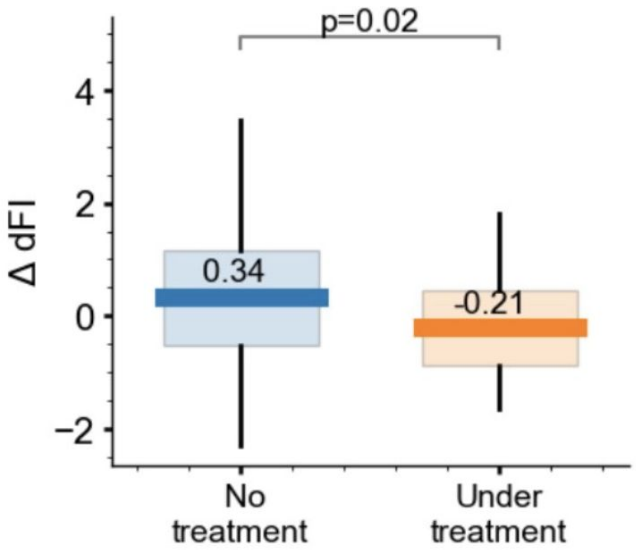


High-fat diet increases the dFI (for male mices)

Measurements of dFI in groups with and without rapamycin treatment



Our result



From article

Absolute values are different, but their relative position is the same

Discussion

The paradigms of aging:

- Consequence of developmental process
- Resulting from a stochastic process of damage accumulation
- Aging is a continuation of developmental growth, driven by genetic pathways (purposeless quasi-program)

Authors state

> “Aging is a particular case of the dynamics of a complex system unfolding near a bifurcation or a tipping point on the boundary of a dynamic stability region”

Manifests itself as small deviations of the organism state variables (physiological indices) get exponentially amplified and lead to the exponential acceleration of mortality

Weak points and improvements

- PCA might be not the best tool to analyze the data
- Usage of 12 features — we suppose not all of them are important
- Tweak the model architecture:
  - consider all available dFIs, not only the last (with RNN/Transformer)
  - or simplify to a couple of linear layers