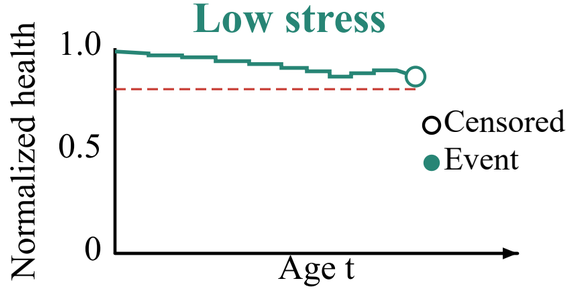
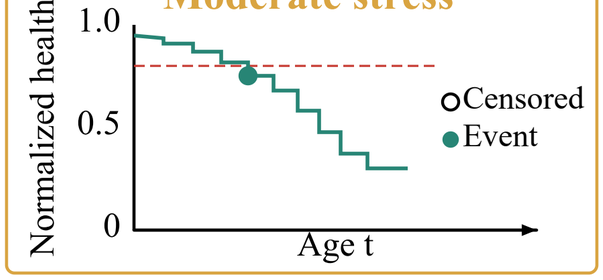
1. Degradation evidence

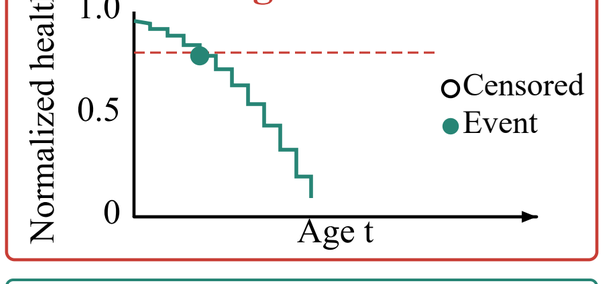
Low stress



Moderate stress



High stress



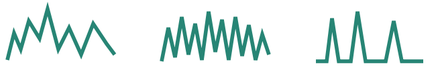
Unbalanced observability.
Fewer low-stress events.

Data record (per unit).
Signals, age, fixed stress, event or censoring.

2. Health and features

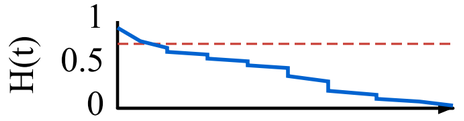
Raw multivariate signals

Optical Electrical Spectral



Health coordinate H(t)

from fixed-reference optical power



Persistent L80 endpoint

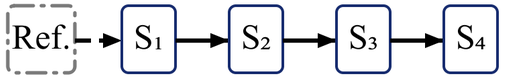
First of five hourly values at or below 0.8

Condition features x(t)

- health
- local rate
- electrical load proxy
- spectral / structural shift
- efficiency

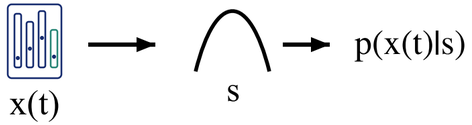
3. NH-HSMM inference

Reference and four states



Fitted Student-t emissions

features → fitted state likelihood

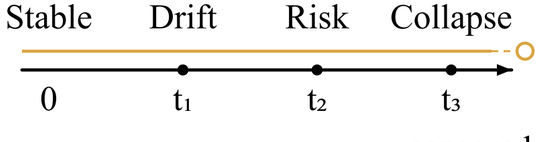


State-specific residence law

D_s depends on stress z

Posterior-weighted residence evidence

Stress changes residence times.



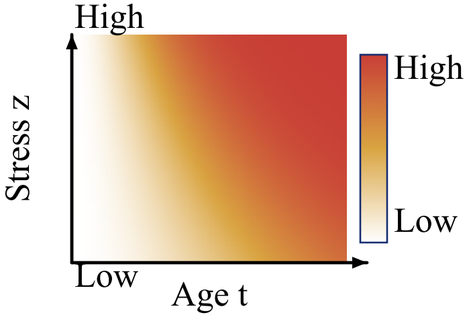
4. Reliability outputs

Closed risk set G

Risk Collapse

Lifetime = first entry into G

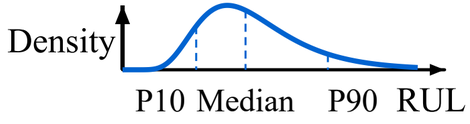
Stress–age risk surface



survival and risk are paired outputs

RUL output

RUL density from condition history



Posterior state and age support condition-updated prediction.