EXPLORATION OF SCENARIO-BASED SIMULATIONS FOR STRESS BENCHMARKING IN SWISS PUBLIC SERVICE

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OUTLINE

- Background and Research Question
- Experimental Setting
- Problem Representation
- Methods
- Results
- Findings and Implications

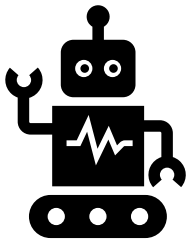
BACKGROUND: STRESS PATTERN RECOGNITION

Individual problem

Individual level

Physiological and non-physiological response to stress

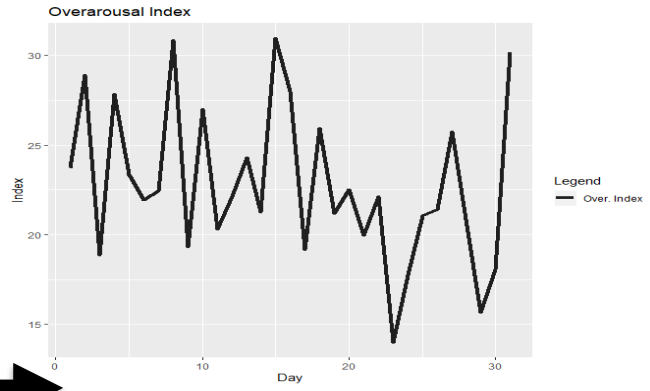
Machine Learning



Individual Stress Status

Neutral, Medium, Low, High Stress

Aggregated Stress Index in Groups

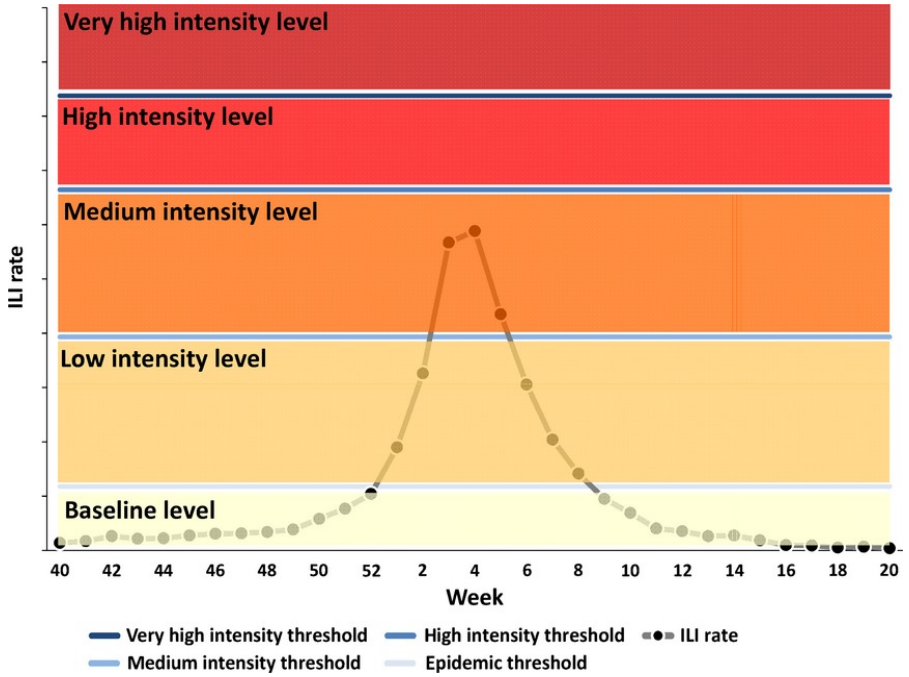


Organizational problem

Group-level (team, department, organization)

Research Problem: Interpretation!
High or Low Stress in Groups?

BACKGROUND: THRESHOLDS



Moving Epidemic Method (MEM), used by the European Centre for Disease Prevention and Control.

Medium, high, and very high intensity thresholds were estimated as the upper limits of the 40%, 90%, and 97.5% one-sided confidence intervals of the geometric mean.

«**LARGE** data»: 8-18 seasons

Research Question: How to construct Thresholds for Stress-Related Index with «**SMALL** data» (no multiple seasons) ?

- **Numerical Simulation approach**

EXPERIMENTAL SETTING (1 OF 2)

Participants:

- 18 public servants

Workplace:

- Swiss Municipal Fiscal Administration

Timeline of experiment:

- 1st of November 2018 to 18th of December 2018

Variable work Intensity:

- Bigger work-related stress in December than in November

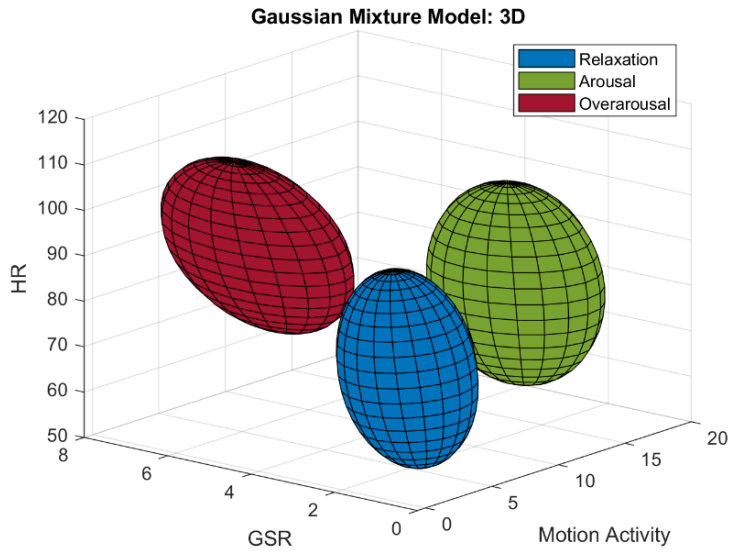
EXPERIMENTAL SETTING (2 OF 2)

Activity:

- Wearable device use including personal bio-feedback on smartphone
- Registration of response to stress including physiological and non-physiological signals

PROBLEM REPRESENTATION: MARKOV PROCESS

1. Input



- HR: Heart Rate
- GSR: Galvanic Skin Response (Measure of Emotional Arousal)
- Motion Activity

Relaxation (R)
Arousal (A)
Overarousal (O)

2. Representation

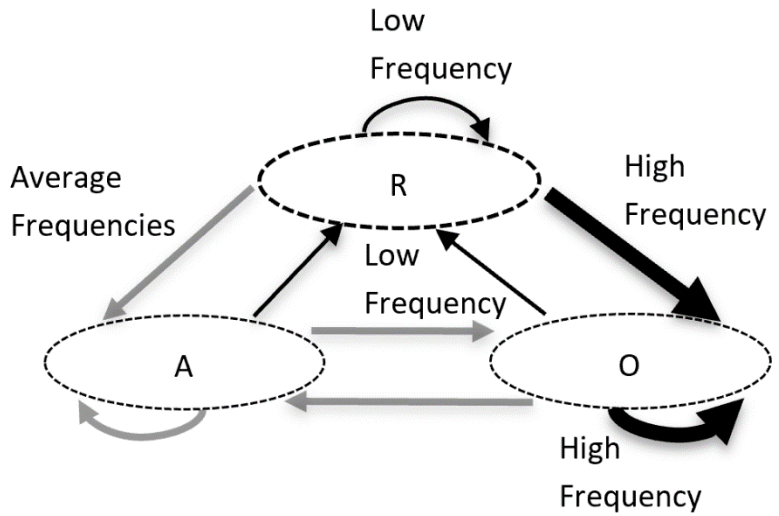
Sample 1											
Time t	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10	…
Series	R	R	R	A	R	O	R	A	R	R	…
Transitions $t \rightarrow (t+1)$	…	$R \rightarrow R$	$R \rightarrow R$	$R \rightarrow A$	$A \rightarrow R$	$R \rightarrow O$	$O \rightarrow$ R	$R \rightarrow A$	$A \rightarrow R$	$R \rightarrow R$	…

METHODS

- Formulate assumptions for High and Low Stress scenarios;
- Support assumptions with data (Block resampling and distributions of parameters);
- Simulate benchmark curves (Markov Chain Models).

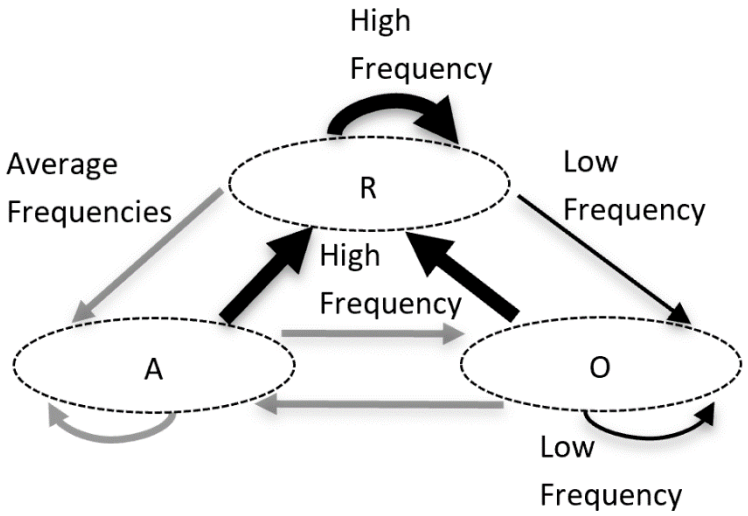
METHODS: FORMULATING ASSUMPTIONS PER SCENARIO

High Stress Scenario:
Downweigh links to class «R»
Upweight links to class «O»



	Mean Frequency
	Low Frequency
	High Frequency

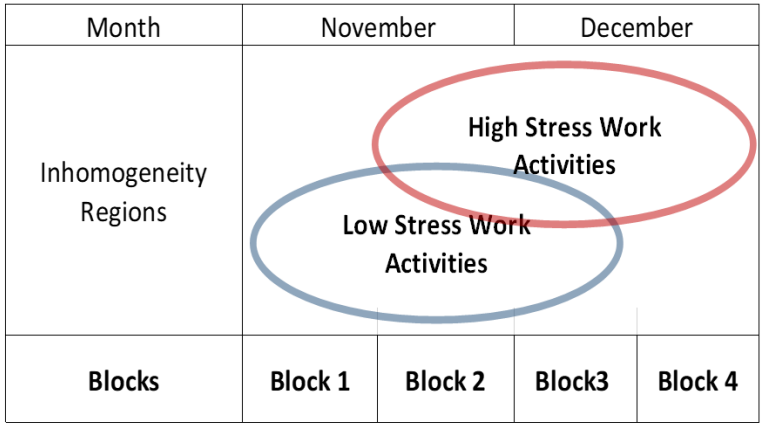
Low Stress Scenario:
Upweight links to class «R»
Downweigh links to class «O»



- Define:
  - Low Frequency ?
  - High Frequency ?

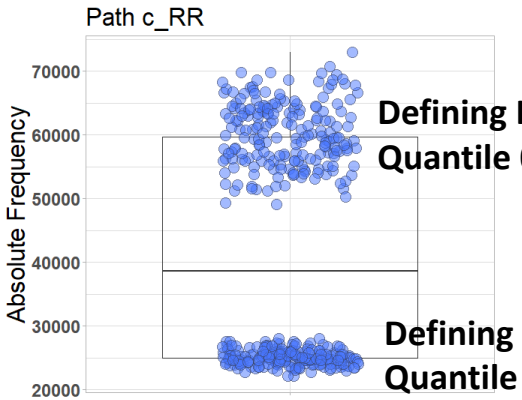
METHODS: SUPPORTING ASSUMPTIONS WITH DATA (1 OF 2)

Block Resampling:



- 4 blocks
- 100 samples per block
- Sample length = 3533

Distribution of parameter: $\boldsymbol{R \rightarrow R}$



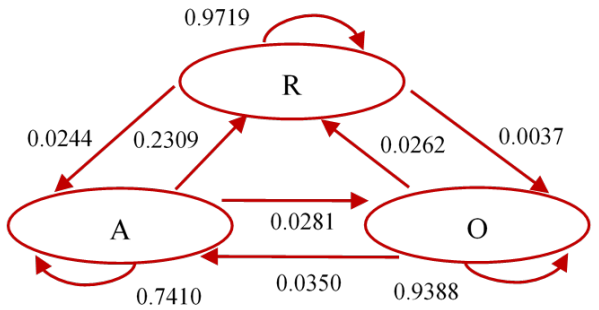
- **(R)** is a major class (89% of weight vs all states)
- **(RR)** has a big influence on simulation models (high scale vs other transitions)

METHODS: SUPPORTING ASSUMPTIONS WITH DATA (2 OF 2)

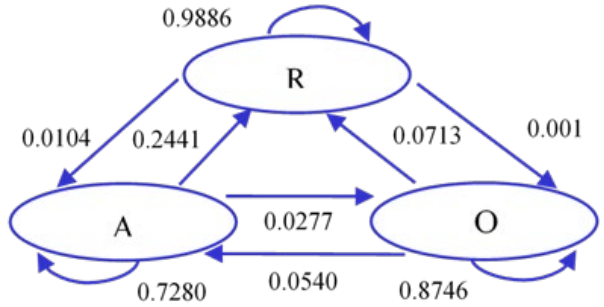
Path	Absolute Frequencies	
	High Stress Scenario	Low Stress Scenario
$R \rightarrow R$	q0.25 (Low Freq.)	q0.75 (High Freq.)
$R \rightarrow A$	mean	mean
$R \rightarrow O$	q0.75 (High Freq.)	q0.25 (Low Freq.)
$A \rightarrow R$	q0.25 (Low Freq.)	q0.75 (High Freq.)
$A \rightarrow A$	mean	mean
$A \rightarrow O$	mean	mean
$O \rightarrow R$	q0.25 (Low Freq.)	q0.75 (High Freq.)
$O \rightarrow A$	mean	mean
$O \rightarrow O$	q0.75 (High Freq.)	q0.25 (Low Freq.)

Normalized Frequencies and State Diagrams:

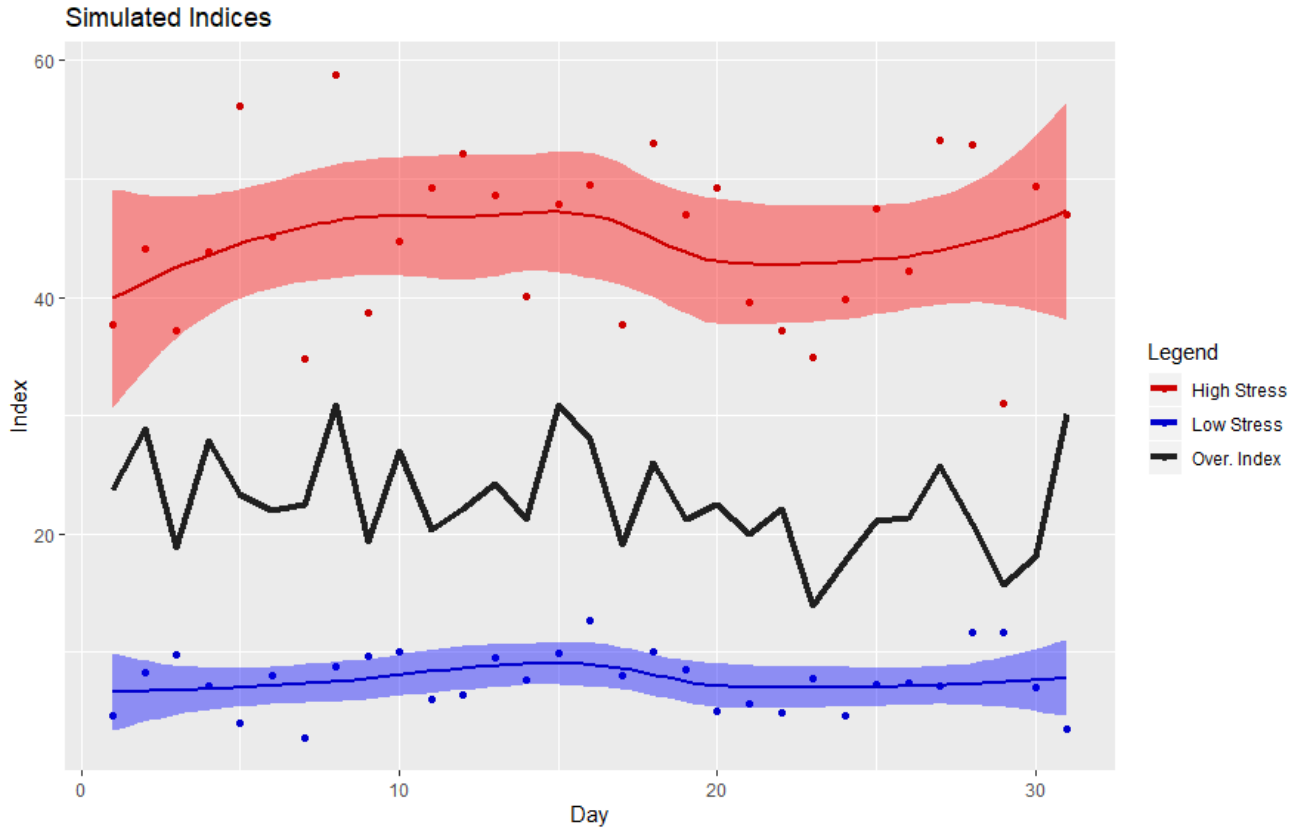
1. High Stress Scenario:



2. Low Stress Scenario



RESULTS: NUMERICAL SIMULATION



- 20 pseudo-users, 8 hours of daily use during 31 days
- 480 daily state transitions
- Sum of “Overarousal” episodes divided by amount of users

FINDINGS (1 OF 2)

Research Contributions to Methodological Knowledge:

- Confirmed possibility of Stress Pattern Recognition at group level (team, department, organization).
- New application of Markov Chain Modeling for simulation of stress-related benchmarks.
- New methodology of constructing stress-related benchmarks with limited historical data in several steps.

FINDINGS (2 OF 2)

Confirmed process of benchmark construction:

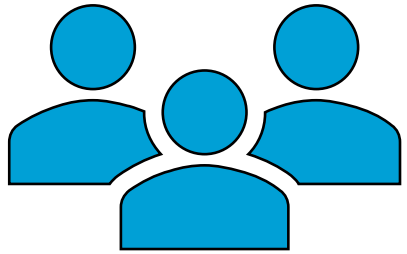
1. Train machine-learning algorithm (GMM or other);
2. Represent problem as a Markov Process;
3. Formulate assumptions for High and Low Stress;
4. Support assumptions with data (Study distributions of state transition frequencies; Estimate parameters from the distributions);
5. Simulate benchmark curves (Markov Chain Models);
6. Overlay stress-related Index (Data aggregation and Weights).

PRACTICAL IMPLICATIONS

Benchmark curves for stress-related Index may serve to:

- Interpret and analyze group-level stress-related indices;
- Compare stress levels across different organizational units;
- Support stress prevention:
  - Support blinded and anonymous group-level stress monitoring;
  - Support the development of new Human Resource Management practices, occupational health and safety policies.
- Identify when stress becomes an organizational problem:
  - Support decision-making on stress management;
  - Monitor the efficacy of stress management practices and interventions;
  - Measure the performance of stress management trainings.

QUESTIONS



Thank you for your attention!