Knowledge Management and Discovery Lab

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OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

FACULTY OF COMPUTER SCIENCE

Learning for clinical diagnostics and prediction

A – Similarity-based learning for prediction

Personalized predictors – a "transferred" neighborhood

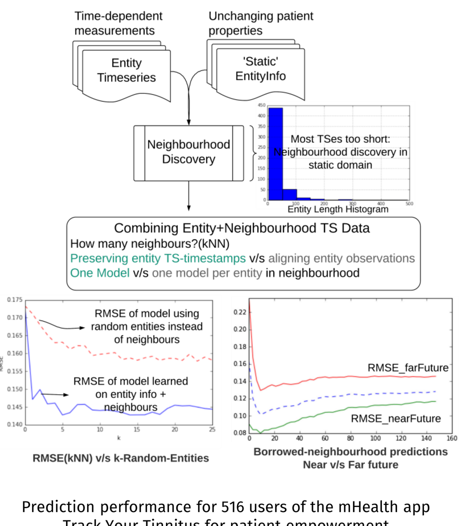
Vishnu Unnikrishnan, Christian Beyer, Pawel Matuszyk, Uli Niemann, Rüdiger Pryss, Winfried Schlee, Eirini Ntoutsi, and Myra Spiliopoulou. Entity-level stream classification: exploiting entity similarity to label the future observations referring to an entity. In: International Journal of Data Science and Analytics (JDSA), (9), 1-15, 2020.

Motivation: Most data streams have entity-level generating processes, which can be exploited for learning.

Approach: *1) Can information from the neighborhood of an entity improve the predictions of its future labels?*

2) Can similarity be learned in another space?

Results: Comparing against k-randomly-chosen entities shows that neighborhood computed over static properties decrease RMSE. The error increases as the prediction moves further into the future.



Prediction performance for 516 users of the mHealth app Track Your Tinnitus for patient empowerment

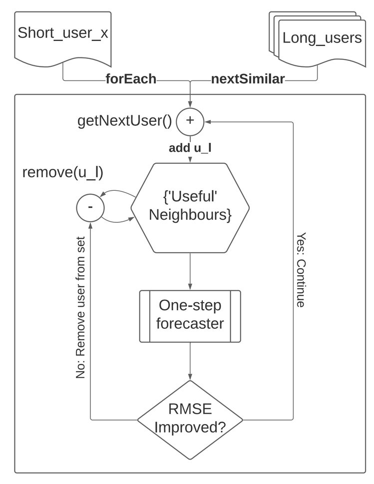
A "discovered" neighborhood

Vishnu Unnikrishnan, Yash Shah, Miro Schleicher, (...), and Myra Spiliopoulou. Love thy Neighbours: A Framework for Error-Driven Discovery of Useful Neighbourhoods for One-Step Forecasts on EMA data. In: Computer-Based Medical Systems (CBMS), 295-300, 2021.

Motivation: "Short" users can be predicted given data from "long" ones, but do all long users help equally?

Approach: For each short user, grow the training-users neighborhood until RMSE increases.

Results: Personalized neighborhoods can use as much as 70% less data while still beating models (2-30% improvement) that train on data from all long users ($N_1 = 12$, $N_2 = 10$).



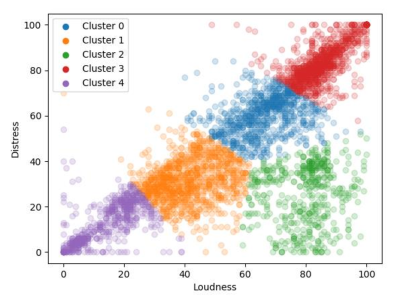
... selecting data to learn

Vishnu Unnikrishnan, Miro Schleicher, Yash Shah, Noor Jamaludeen, (...), and Myra Spiliopoulou. The Effect of Non-Personalised Tips on the Continued Use of Self-Monitoring mHealth Applications. Brain Sciences, (10)12, 924, 2020.

Motivation: Ecological momentary assessment (EMA) data may express complex disease patterns that need to be learned separately.

Approach: Clustering the EMAs with expert guidance

Results: Within-cluster models gave lower overall RMSE (N = 36).



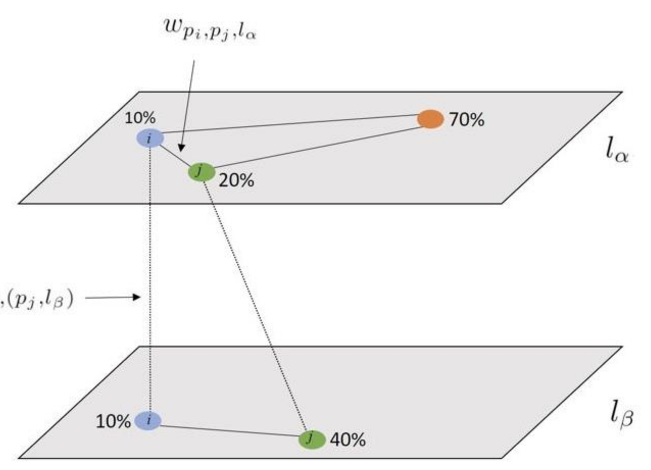
B – Minimizing the demand for data and features for diagnostics

Phenotyping with a minimal number of featuresets

Clara Puga, Uli Niemann, Vishnu Unnikrishnan, Miro Schleicher, Winfried Schlee, and Myra Spiliopoulou. Discovery of Patient Phenotypes through Multi-layer Network Analysis on the Example of Tinnitus. In: Data Science and Advanced Analytics (DSAA), 2021.

Goal: Exploit patient questionnaire inter-relationships for phenotype construction

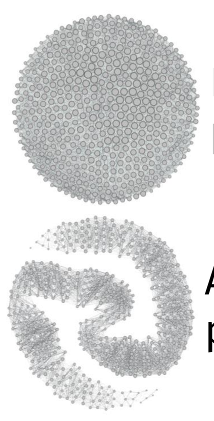
Approach: Mapping questionnaire data into a multi-layer network → The number of layers is optimized, so that redundant data are not added.



1. Representation of patients in multi-layered graphs

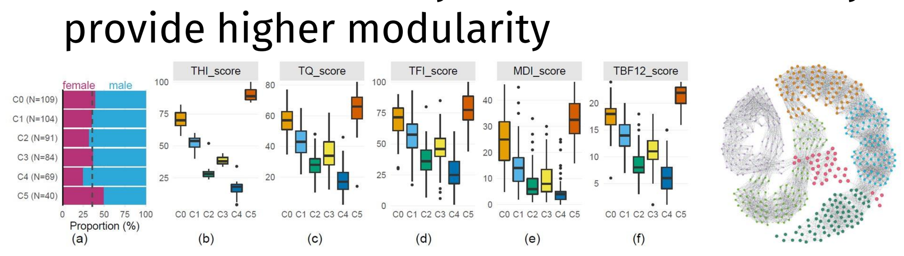
- Patient → node
- Distance between patients → weighted edge
- Questionnaire → layer

2. Graph Pruning



3. Community detection and layer selection

- Community detection via Leiden algorithm
- Layers are chosen based on their similarity
- The least similar layers are added if they provide higher modularity



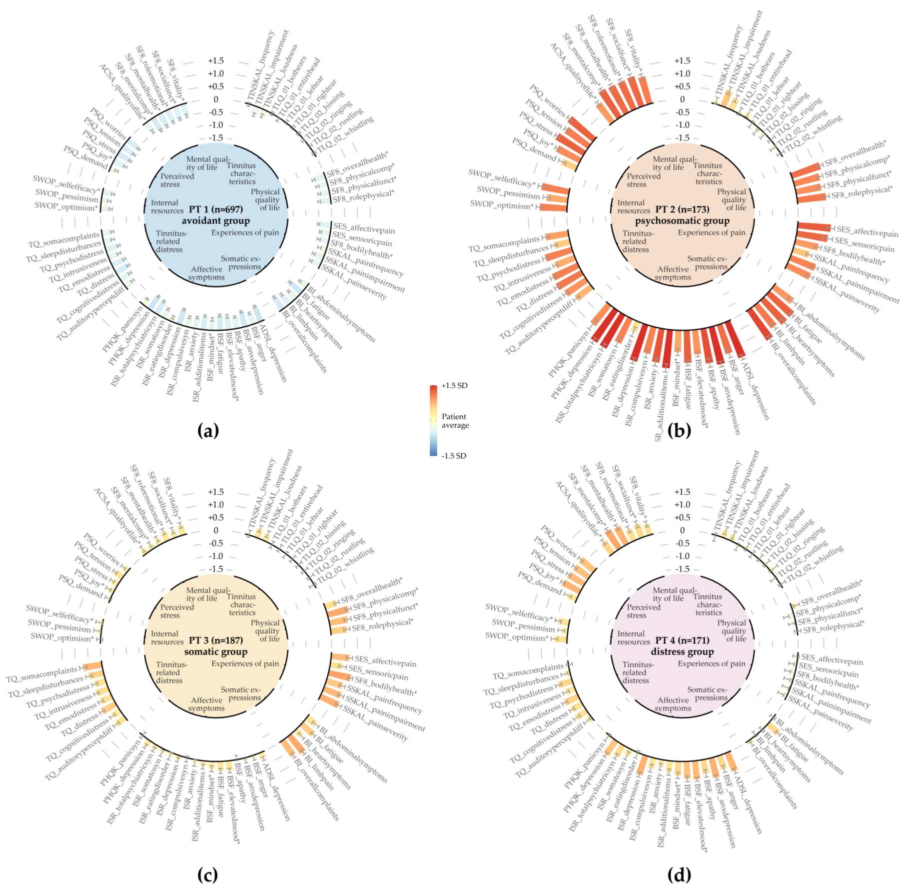
4. Prediction of treatment outcome per community

- Comparison with baseline (prediction on all patients)
- Community-specific treatment outcome prediction outperforms baseline

Patient phenotyping via cluster analysis and visual comparison

Uli Niemann, Petra Brueggemann, Benjamin Boecking, Matthias Rose, Myra Spiliopoulou, and Birgit Mazurek. Phenotyping chronic tinnitus patients using self-report questionnaire data: cluster analysis and visual comparison. Scientific Reports, (10)1:16411, 2020.

We found 4 tinnitus phenotypes with X-means clustering using self-report questionnaire data of 1228 patients with chronic tinnitus.



Radial bar graphs visualizing the phenotypes. Bars show within-cluster feature averages in terms of standard deviations away from the study population mean. To allow for easy navigation, features are grouped into expert-defined categories, displayed in the inner circle.

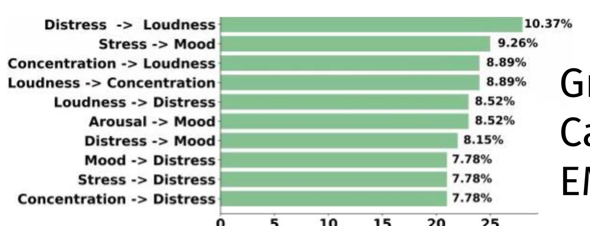
C – Delivering understandable results for the clinical expert

Circadian conditional Granger causalities in EMA data

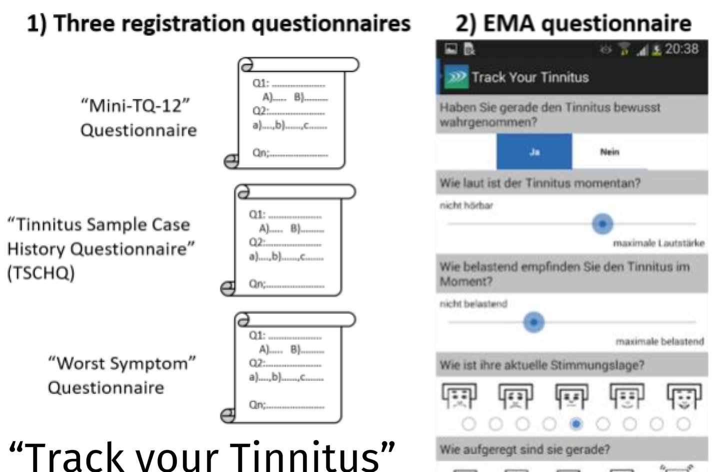
Noor Jamaludeen, Vishnu Unnikrishnan, Ruediger Pryss, Johannes Schobel, Winfried Schlee, and Myra Spiliopoulou. Circadian Conditional Granger Causalities on Ecological Momentary Assessment Data from an mHealth App. In: Computer-Based Medical Systems (CBMS), 354-359, 2021.

Objectives:

1. Granger causalities (GCs) in ecological momentary assessment (EMA) data
2. Correlation between the inferred GC relationships
3. Extraction of the GC relationships at early stages



Granger Causalities on EMA data



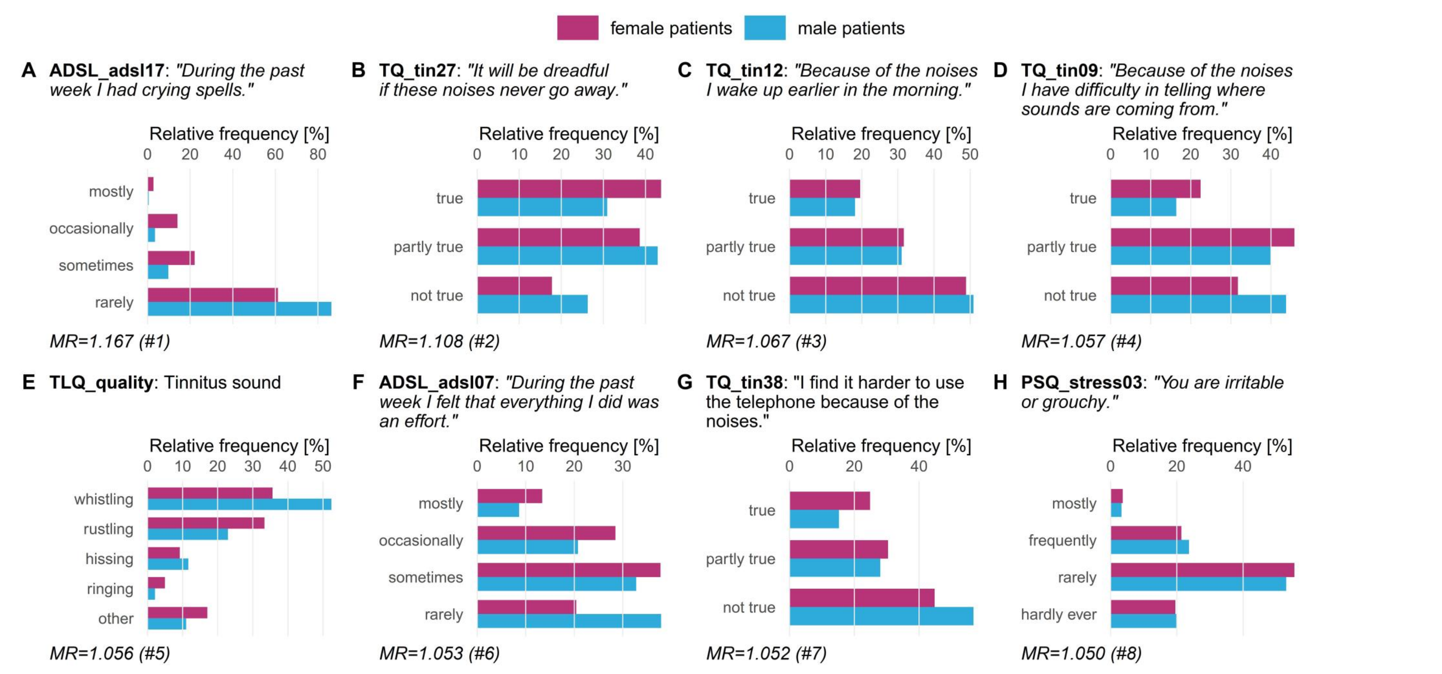
"Track your Tinnitus" mHealth app

$\mathcal{G}$-causal Relationship c	$\lvert U_c\rvert/\lvert U\rvert$	Top-9 predictive Features at registration (Question, Answer)	Confidence(c→(q,a))	PriorProbability(q,a)	Lift(c→(q,a))
Mood $\xrightarrow[\text{ccgCauses}]{}$ **Arousal**	7.04%	TSCHQ.q_{28}="Usually"	0.21	0.04	5.17
		TSCHQ.q_{20}= "YES"	0.21	0.05	4.37
Distress $\xrightarrow[\text{ccgCauses}]{}$ Mood	8.15%	TSCHQ.q_{14}= "noise"	0.18	0.04	4.09
Distress $\xrightarrow[\text{ccgCauses}]{}$ **Arousal**	5.93%	TSCHQ.q_{15}="very high frequency"	0.25	0.07	3.55
Concentration $\xrightarrow[\text{ccgCauses}]{}$ Mood	7.04%	TSCHQ.q_{26}="YES"	0.21	0.06	3.55
		TSCHQ.q_{28}="Sometimes"	0.21	0.06	3.55
Arousal $\xrightarrow[\text{ccgCauses}]{}$ Concentration	5.56%	TSCHQ.q_{29}="NO"	0.27	0.08	3.43
Loudness $\xrightarrow[\text{ccgCauses}]{}$ **Arousal**	5.56%	TSCHQ.q_3="Both Sides"	0.33	0.10	3.33
Loudness $\xrightarrow[\text{ccgCauses}]{}$ Distress	8.52%	worstsymptom ="Because of the tinnitus I am more sensitive to environmental noises."	0.30	0.09	3.29

Link GCs with registration data using association rules

Gender-specific differences in tinnitus patients

Uli Niemann, Benjamin Boecking, Petra Brueggemann, Birgit Mazurek, and Myra Spiliopoulou. Gender-Specific Differences in Patients With Chronic Tinnitus—Baseline Characteristics and Treatment Effects. Frontiers in Neuroscience, (14):487, 2020.



The most important questionnaire items for gender classification in tinnitus patients

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CHRODIS+ IMPLEMENTING GOOD PRACTICES FOR CHRONIC DISEASES

UNITI

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