AI Labs

Real-time learning across multiple healthcare facilities for decision support in psychiatry

PsyData, participant in AI Lab for Healthy Living

Dr. Rosanne J. Turner (PsyData, Brain Center, UMC Utrecht)
Material presented on this poster resulted from joint work of PsyData with Digital Health (UMCU), Analytics & Research Tooling (UMCU), Data Science (Parnassia Groep), Machine Learning Group (CWI) and the Enabling Personalised Interventions consortium (NWO)

0. Clinical text

Patient was admitted with severe anxiety. Today, they were less anxious and depressed. Their participation in ward activities did not improve, but they showed more self-confidence.

1. Split sentences

1.Patient was admitted with severe anxiety.
2.Today, they were less anxious and depressed.
3.Their participation in ward activities did not improve, but they showed more self-confidence.

2. Detect themes

1.Patient was admitted with severe anxiety$_{symptom}$.
2.Today, they were less anxious$_{symptom}$ and depressed$_{symptom}$.
3.Their participation$_{social}$ in ward activities did not improve, but they showed more self-confidence$_{well-being}$.

3. Detect change

1.Patient was admitted with severe anxiety.
2.Today, they were less$_{change}$ anxious and depressed.
3.Their participation in ward activities did not improve$_{change}$, but they showed more$_{change}$ self-confidence.

4. Check context

1.- *(did not pass previous step, no further analysis)*
2.Today$_{current}$, they were less anxious and depressed.
3.Their participation in ward activities did not$_{negated}$ improve, but they showed more self-confidence.

5. Calculate score per sentence, per theme

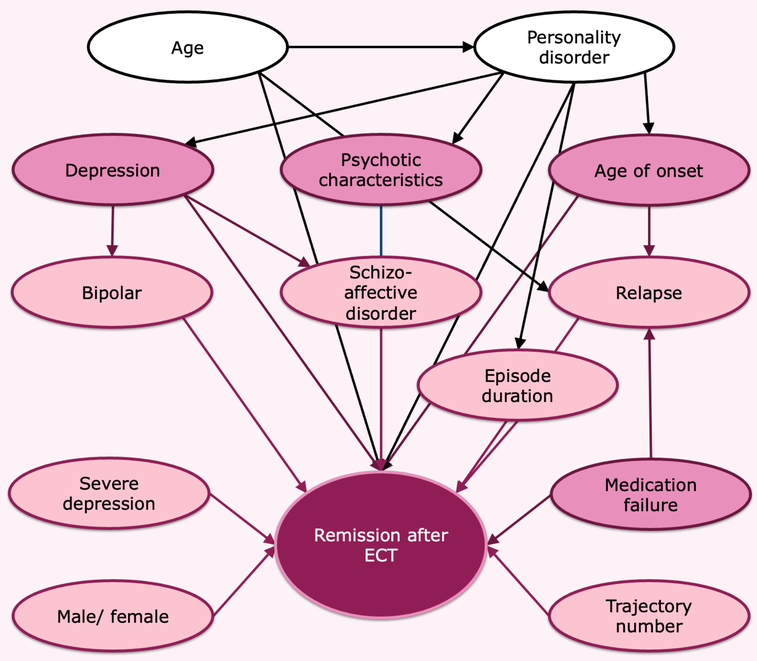
1. -
2. Symptom reduction: -1 (anxious) x -1 (less) + -1 (depressed) x -1 (less) = +2
3. General well-being: 1 (self-confidence) x 1 (improved) = +1

Feature extraction

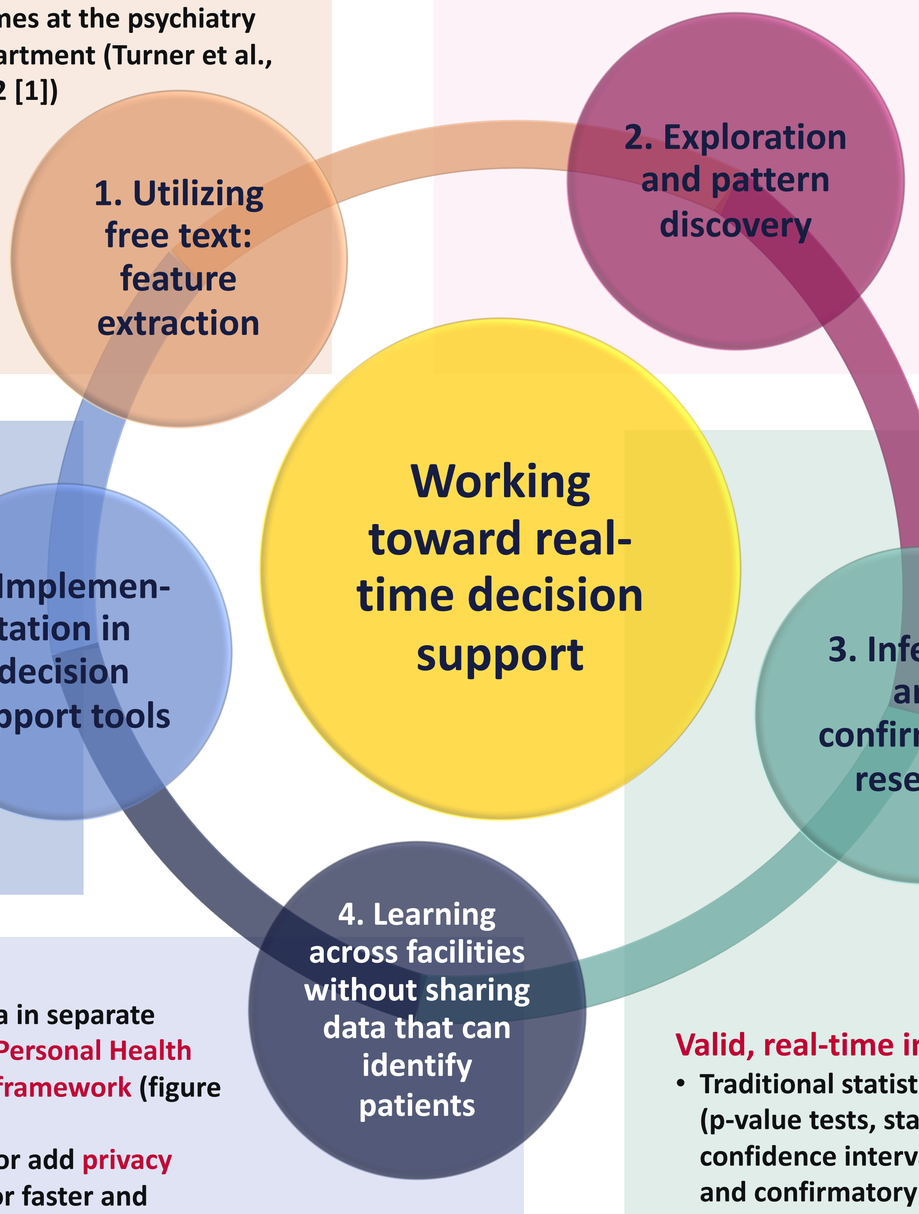
- **Feature extraction from routinely written clinical text with the goal of pattern discovery is one of the core activities of the PsyData team**
- **Tools: MedCAT, SpaCy, Prodigy (example on the left), PsyNLP (rule-based context detection)**
- **On the left: a pipeline designed for extracting phrases concerning one of four treatment outcome themes at the psychiatry department (Turner et al., 2022 [1])**

Pattern discovery

- **Bayesian networks: causal discovery in tabular data**
- **Allow for integrating expert knowledge: network on the right based on systematic review, psychiatrists' input and UMCU data (Van der Does et al., 2023 [2]) and especially apt for learning across multiple facilities**
- **Other projects: (deep) supervised learning, clustering, ensemble methods**



Subgraph of the Bayesian network including all found predictors for remission of psychiatric pathology after electroconvulsive therapy (ECT), constructed with a combination of expert knowledge and UMCU data [2].



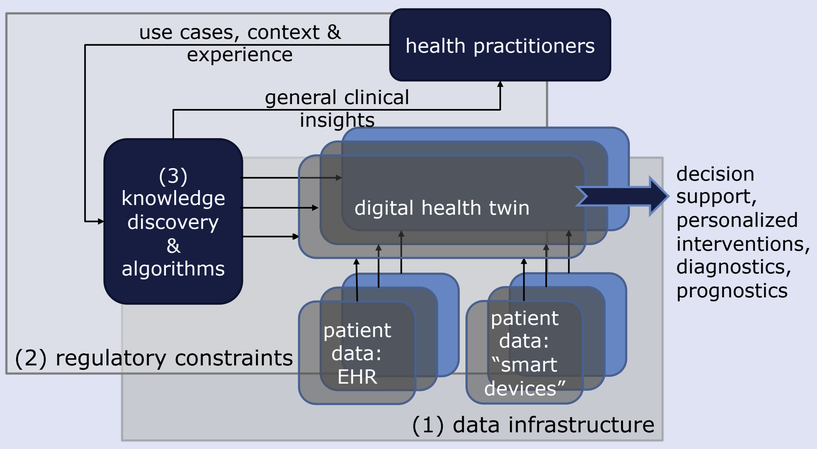
Goal: from validation studies to implementation in routine clinical care

- First proof of concept: predicting aggression in collaboration with Parnassia Groep
- Requirements to move on from research stage (ideas? Contact us!):
  - High quality software applications
  - High quality data infrastructure between facilities
  - Data readiness of participants (FHIR)

Learning across facilities

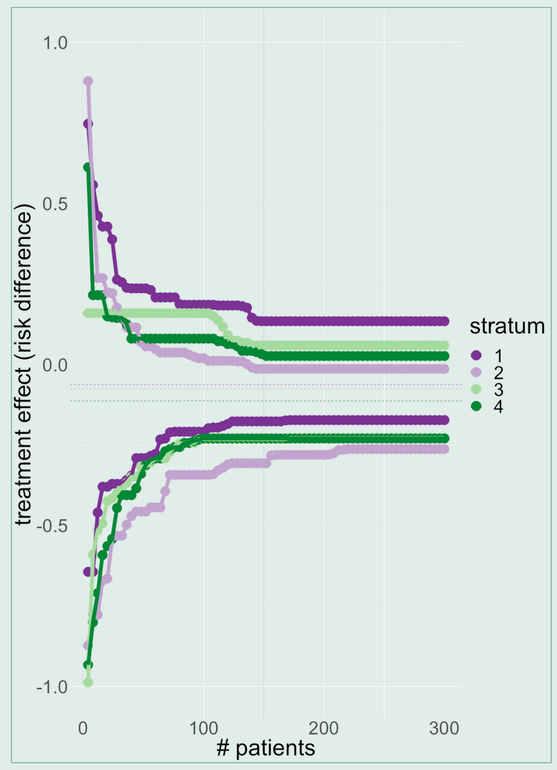
- Federated learning: let algorithms visit data in separate locations and combine at central location. Personal Health Train, Enabling Personalized Interventions framework (figure below [4])
- Future goal: create synthetic dataset and/ or add privacy preserving machine learning to pipelines for faster and easier collaboration with external parties

The EPI framework [4]: tools and software to create a data infrastructure, regulatory constraints and federated learning algorithms to safely learn across multiple locations

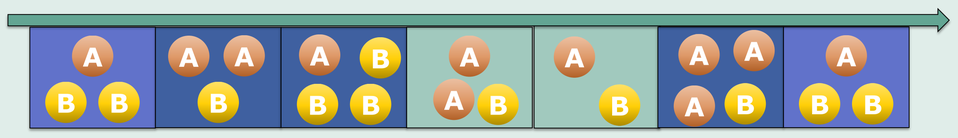


Valid, real-time inference

- Traditional statistical techniques (p-value tests, standard confidence intervals) for inference and confirmatory research are not valid in a setting for continuous learning
- Developed new algorithms to perform valid hypothesis tests and estimate confidence intervals in real-time, across facilities
- Allows for continuously tracking study progress in a dashboard, to decide on best treatment as quickly as possible



Above: example of what a dashboard could look like for following real-time confidence intervals in a stratified study setup (such as ANOVA or a CMH setup) [3]
Below: example of a data stream in random order that can be analysed in a stratified study setup: after each data block can recalculate the confidence interval and p-value



References

1. Figure 1 from Rosanne J. Turner, Femke Coenen et al. Information extraction from free text for aiding transdiagnostic psychiatry: constructing NLP pipelines tailored to clinicians' needs. BMC Psychiatry. June 2022.
2. Figure adapted from Yuri van der Does, Rosanne J. Turner et al. Outcome Prediction of Electroconvulsive Therapy using a Bayesian Network model based on Clinical Information, presented at SOBP, 2023.
3. Figure adapted from Rosanne J. Turner and Peter D. Grünwald. Safe Sequential Testing and Effect Estimation in Stratified Count Data. Oral presentation at AISTATS 2023, published in conference proceedings PMLR 206. February 2023.
4. Figure adapted from the EPI Consortium. Epi: Enabling personalized interventions., 2019. URL https://enablingpersonalizedinterventions.nl.

uu.nl/ailabs

psydata@umcutrecht.nl