

# preha

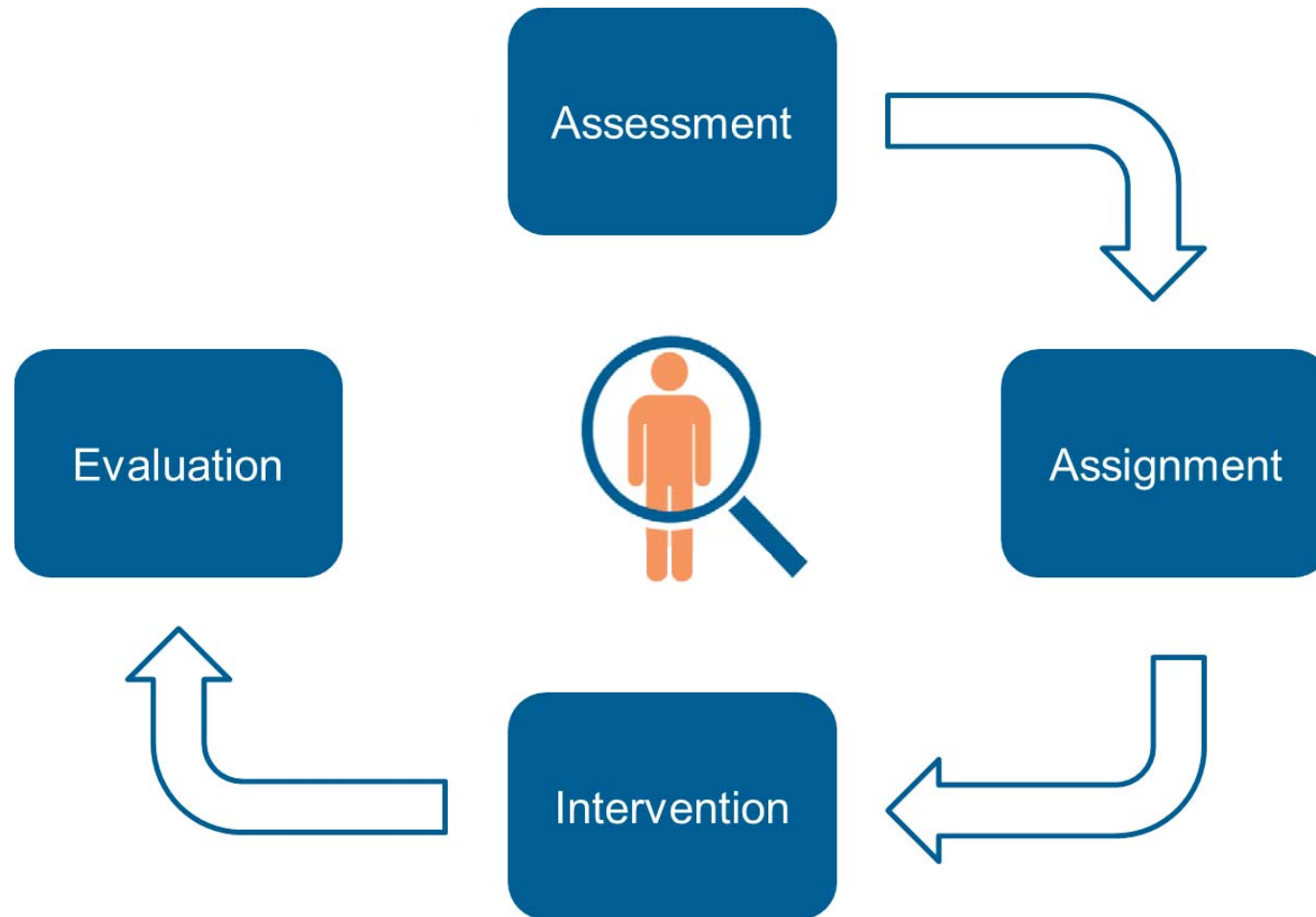
## Establishing Precision Rehabilitation with Visual Analytics

Georg Bernold, Kresimir Matkovic,  
M.Eduard Gröller, Renata G. Raidou





# Conventional Rehabilitation



- Data
- Resources
- Users
- Tasks



**preha**: a new approach to tackle the analysis of  
precision **reha**bilitation data.

Two main components:

1. A detailed data–users–tasks analysis
2. A visual analytics dashboard approach within **preha**



# Data–Users–Tasks Analysis



# Data–Users–Tasks Analysis

46,000 cases  
2012 – 2019

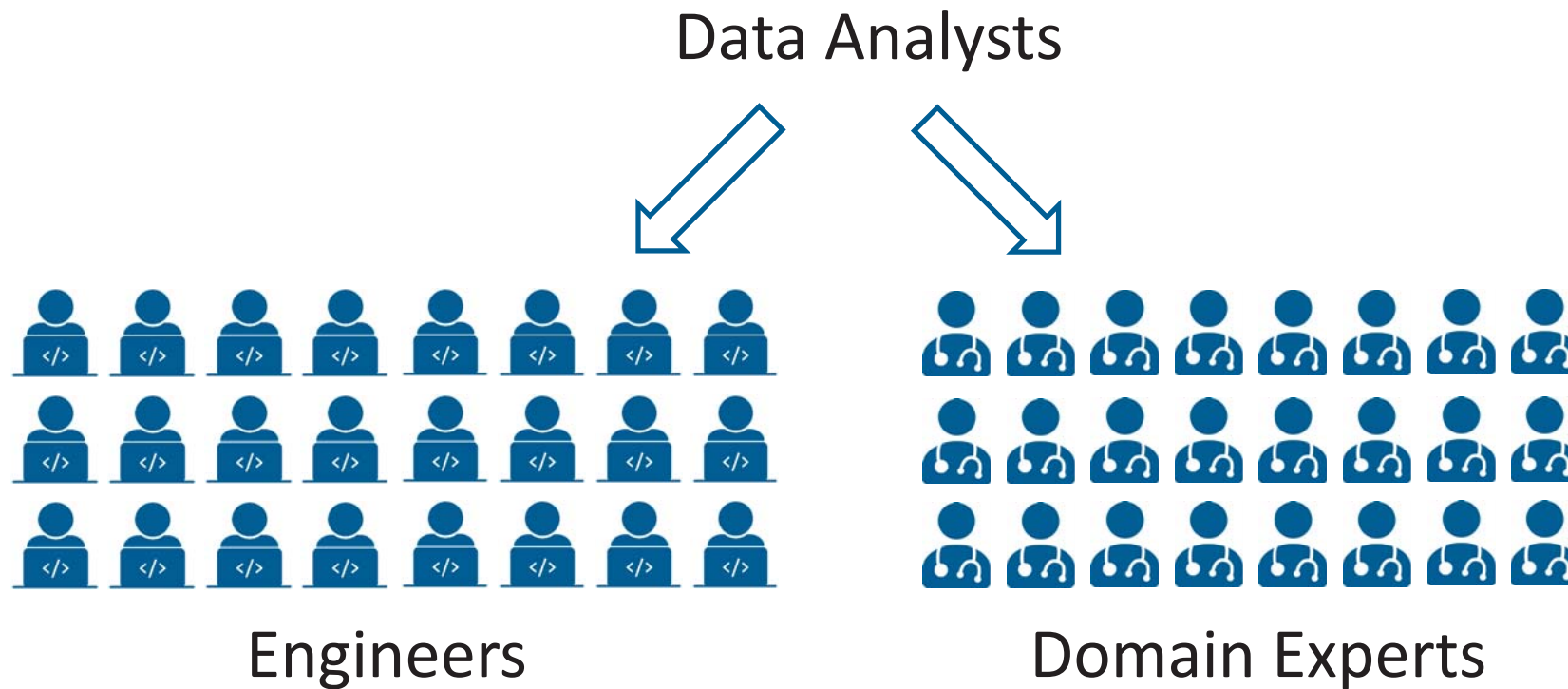


Demographic			Medical				Therapy <sup>1</sup>
Age	Sex	Zip Code	Diagnosis	Insurance	ScoreX <sup>2,3</sup>	ScoreY <sup>2,3</sup>	
67	male	1234	J44	Insurance A	170m	A-B	{a,b,c}
85	female	1235	I67	Insurance B	13.2 meter	-	{a,b,c,d}
47	female	1236	M17.9	Insurance A	-	C	{d,e,f}

large – heterogeneous – high-dimensional<sup>1</sup> – inconsistent<sup>2</sup> – missing<sup>3</sup>

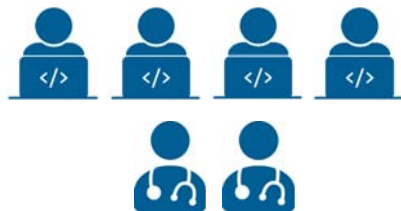


# Data–Users–Tasks Analysis





Interviews



30-50 minutes  
semi-structured

Abstract Tasks



typologies  
for each task



**Eng1:** Provide meaningful data partitions



**Eng2:** Prepare templates for patient assessment

**Eng3:** Prepare templates for clinical benchmarking

**Eng4:** Predict rehabilitation outcome

**Exp1:** Show rehabilitation outcome to patients

**Exp2:** Perform clinical benchmarking



**Exp3:** Explore clinical datasets

**Exp4:** Analyze data for clinical studies

**Exp5:** Intervention planning



**Eng1:** Provide meaningful data partitions



**Eng2:** Prepare templates for patient assessment

**Eng3:** Prepare templates for clinical benchmarking

**Eng4:** Predict rehabilitation outcome

**Exp1:** Show rehabilitation outcome to patients

**Exp2:** Perform clinical benchmarking



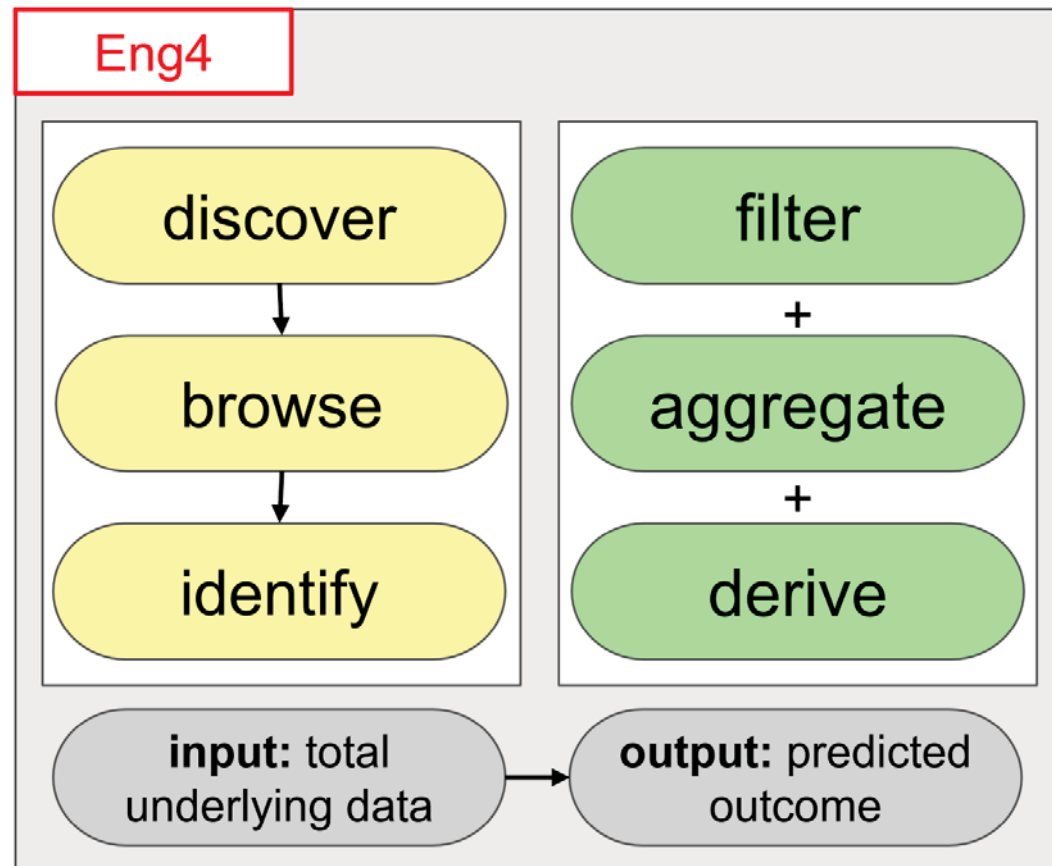
**Exp3:** Explore clinical datasets

**Exp4:** Analyze data for clinical studies

**Exp5:** Intervention planning



# Eng4: Predict Rehabilitation Outcome

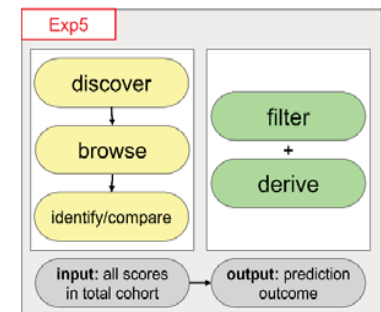
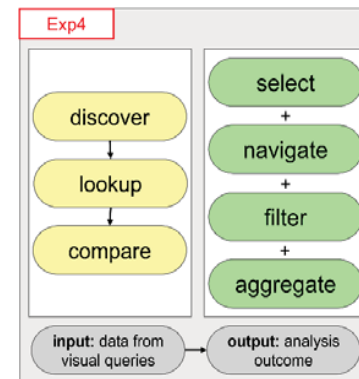
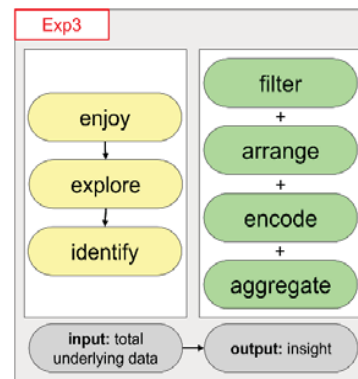
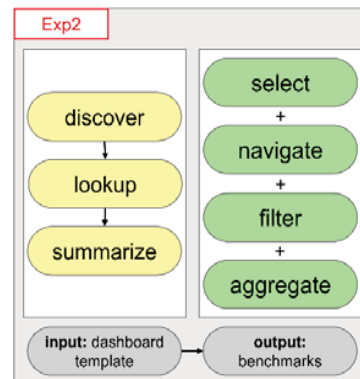
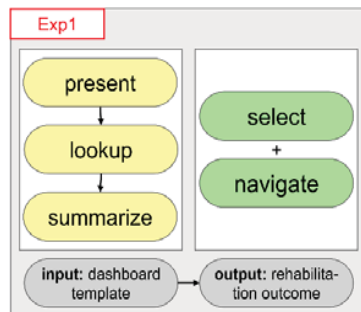
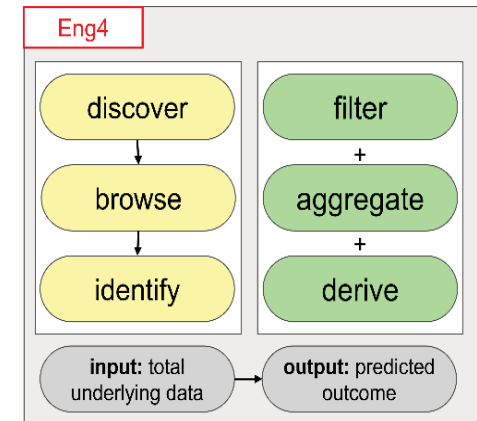
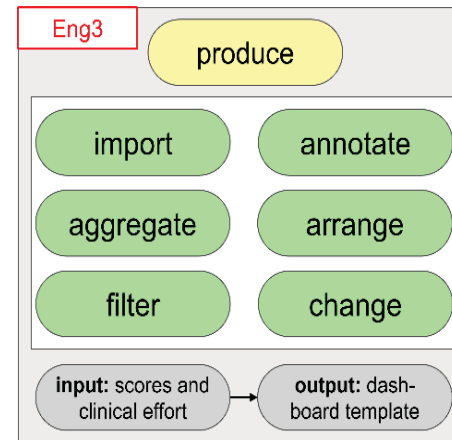
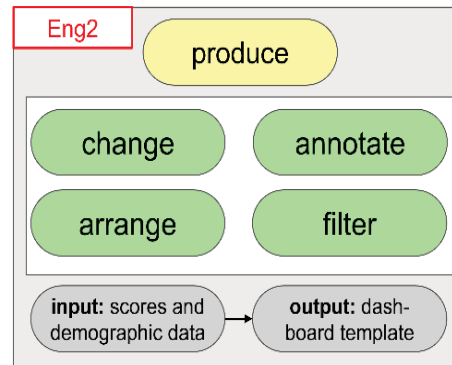
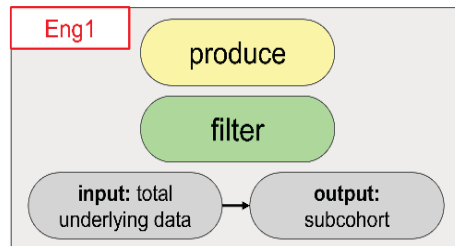


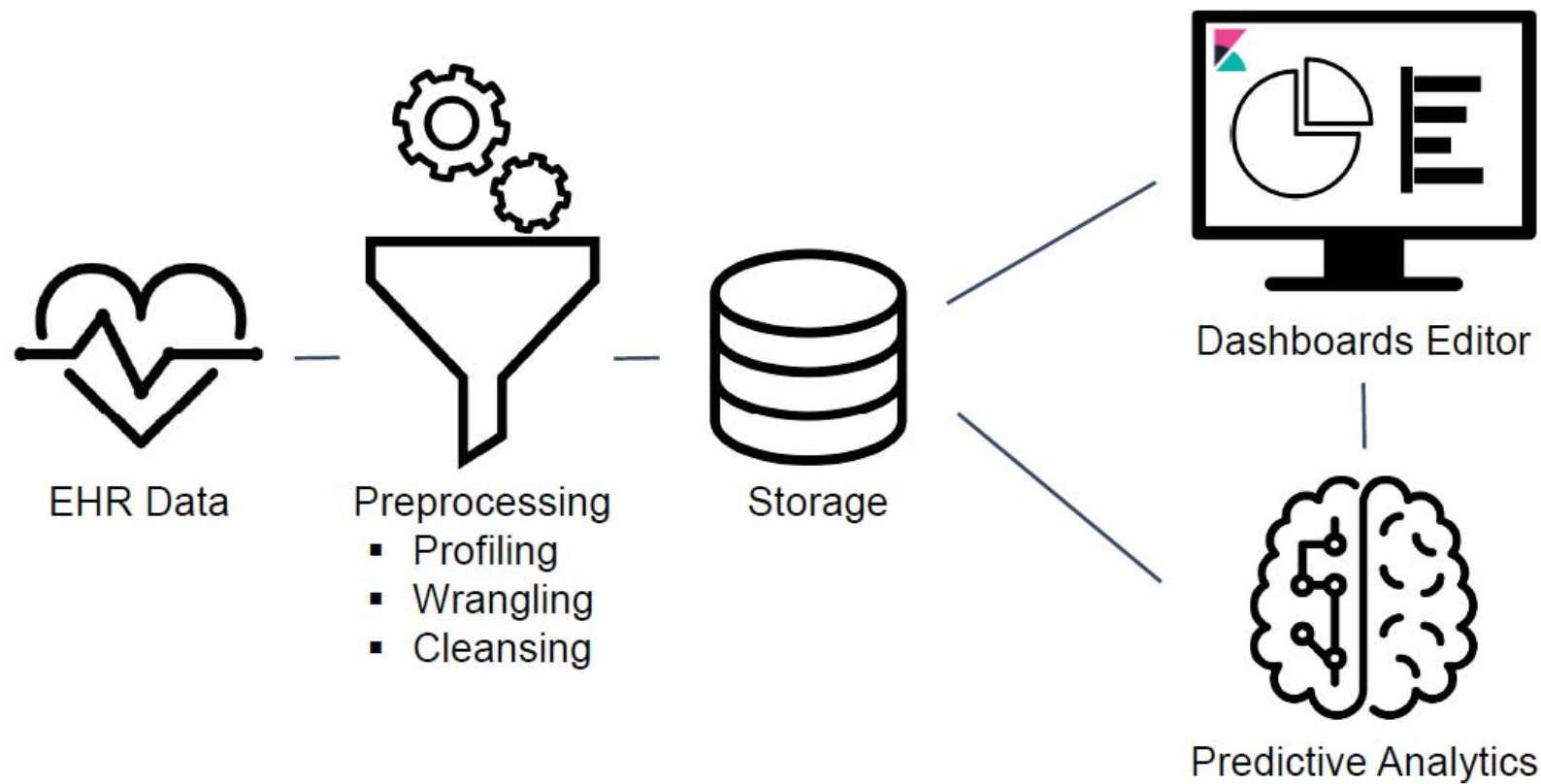
What?  
Why?  
How?

[inspired by Brehmer et al. 2013]



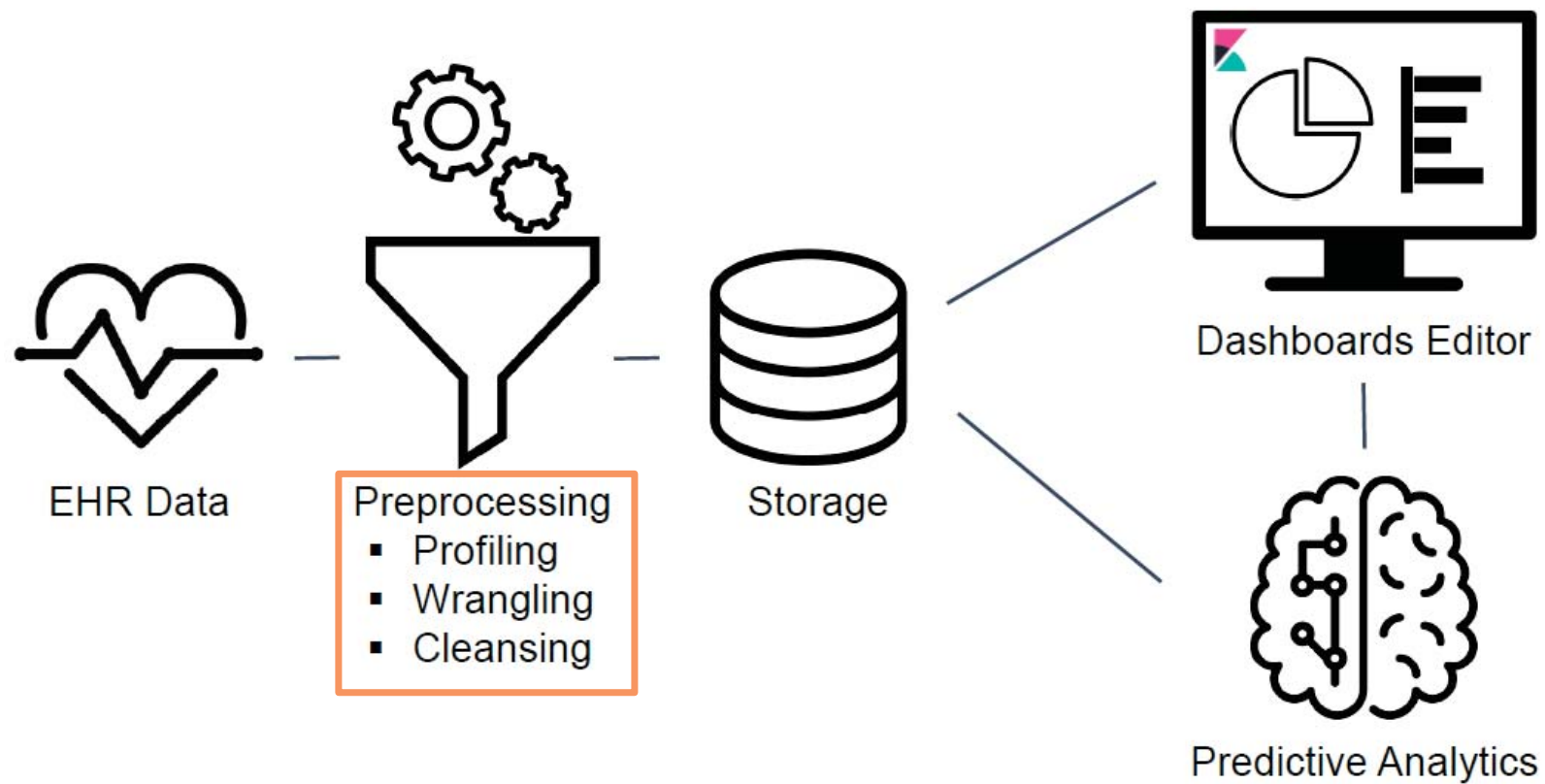
# Typologies for All Tasks





\* if required by task

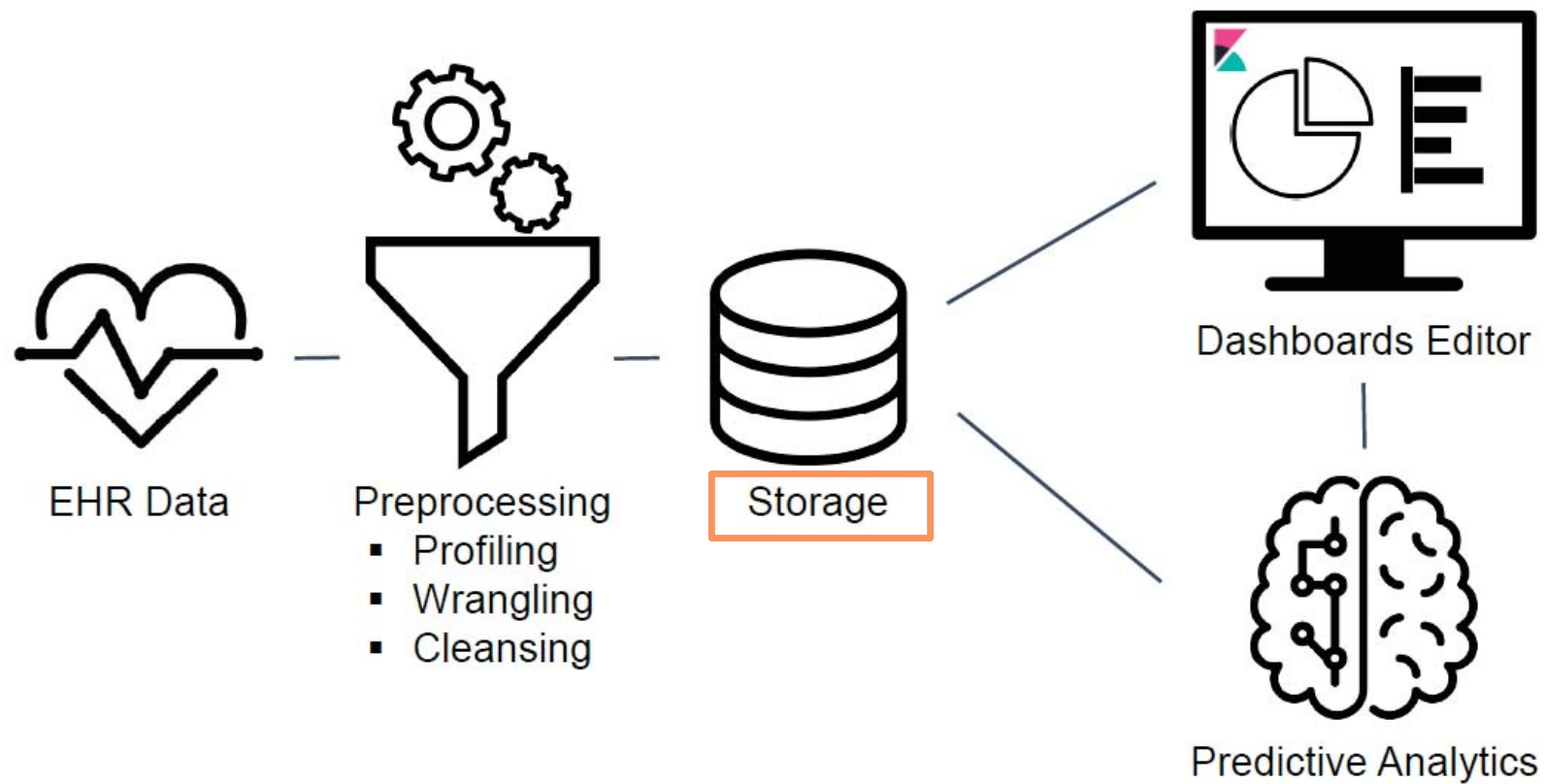


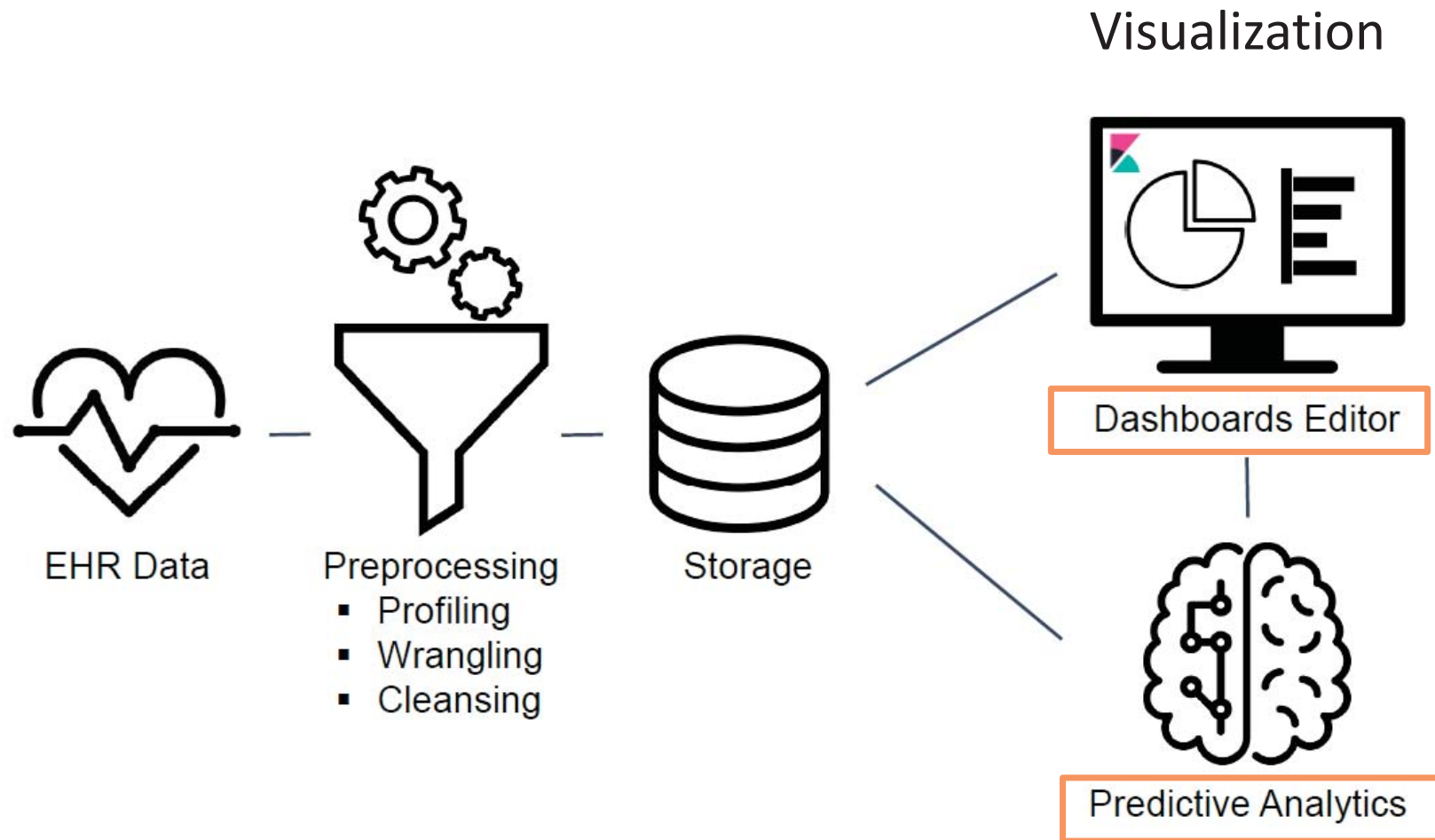


- Rule-based approach, done once: easy to introduce new rules
- Profiling: identification and communication of quality problems
  - Set of regular expressions/rules defined by the users
  - Whatever doesn't match these → “dirty”
- Wrangling: modifying structure to make it suitable for processing
  - Standardization of tables and scores
  - Each patient is assigned one (non-redundant) row in a data table
- Cleansing: correcting dirty data
  - We know how correct data should look like
  - Cleansing programs/rules to match this appearance









# Visualization

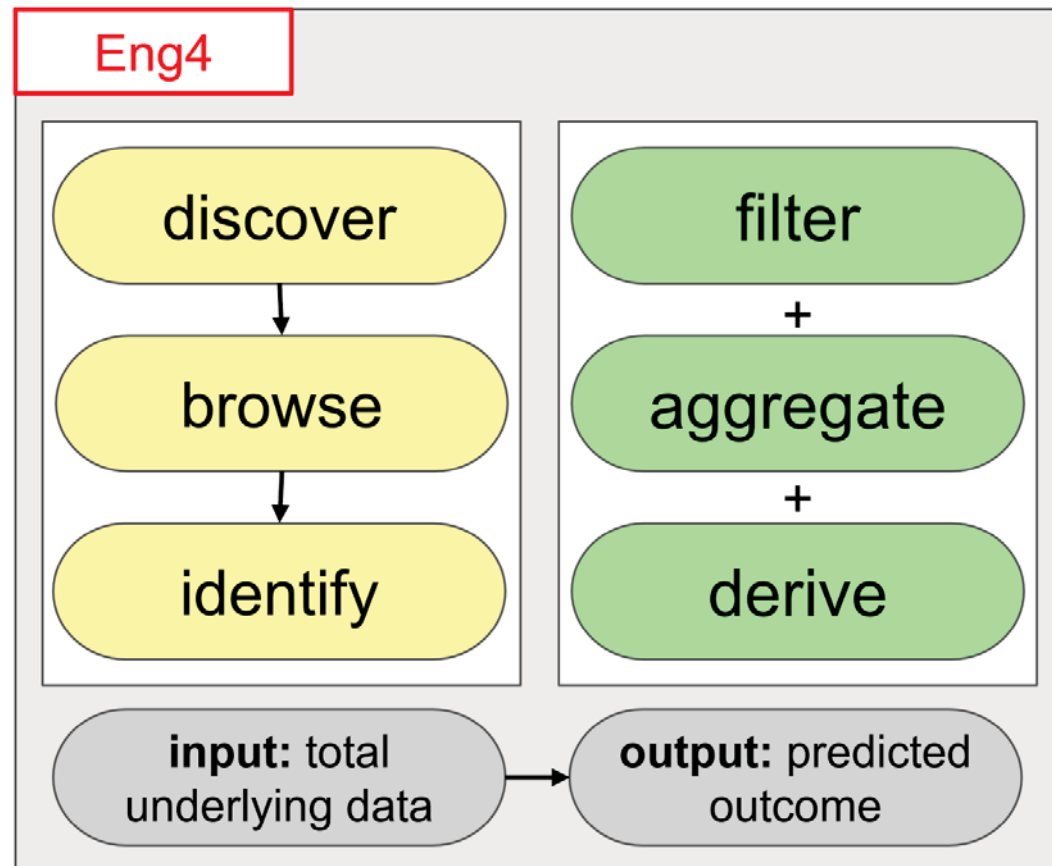
- Flexible, reusable, adaptable, expressive

- **Kibana** framework:

- All basic visualizations
- Extensible through d3.js
- Supports multiple linked views
- Interaction functionality
- Predictive analysis support



# Eng4: Predict Rehabilitation Outcome



What?  
Why?  
How?

[inspired by Brehmer et al. 2013]



Add a filter +

Filter

Visualize interesting  
characteristics of  
cohort

Predict assessment scores

Visualize interesting characteristics of cohort

Visualize interesting characteristics of cohort

Add a filter +

Filter

Visualize interesting  
characteristics of  
cohort**Predict assessment scores**

Visualize interesting characteristics of cohort

Visualize interesting characteristics of cohort

> Search... (e.g. status:200 AND extension:PHP)

Options

Refresh

Add a filter +

Filter

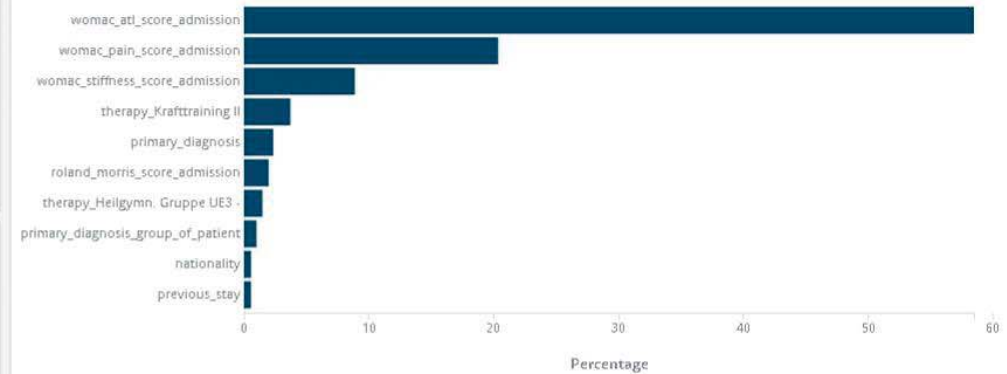
Visualize interesting characteristics of cohort

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Prediction of the WOMAC ATI Discharge Score

Womac Atl Score Discharge

Predicted value: 41.50  
Prediction accuracy: 80.46%  
Prediction error: 15.81



Visualize interesting characteristics of cohort

Add a filter +

Filter

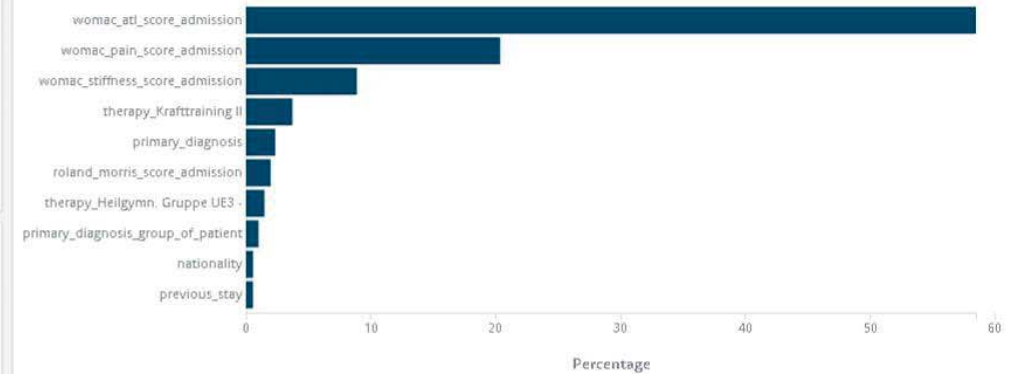
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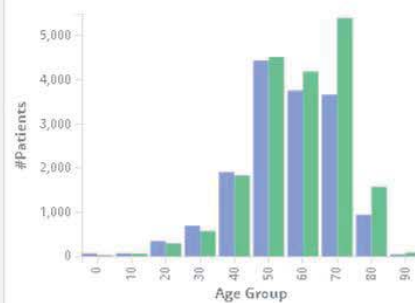
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Add a filter +

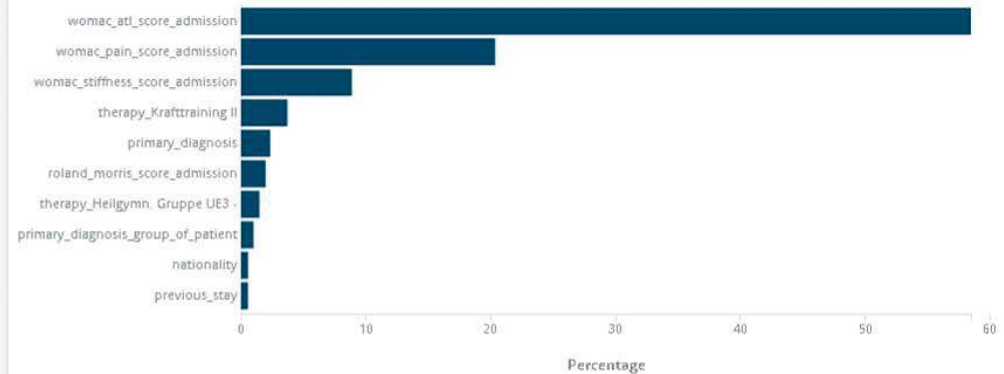
Filter

Patient Age Distribution

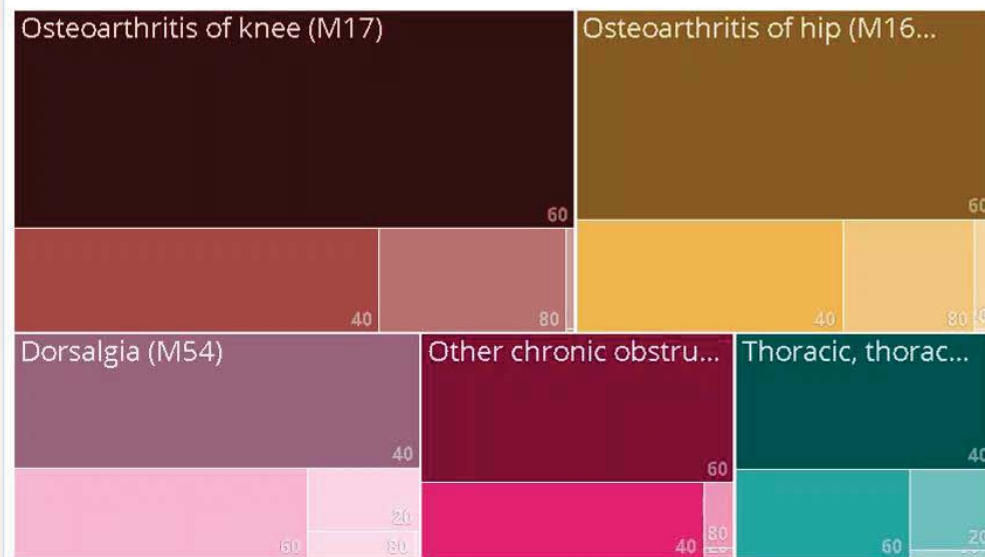


Prediction of the WOMAC ATL Discharge Score

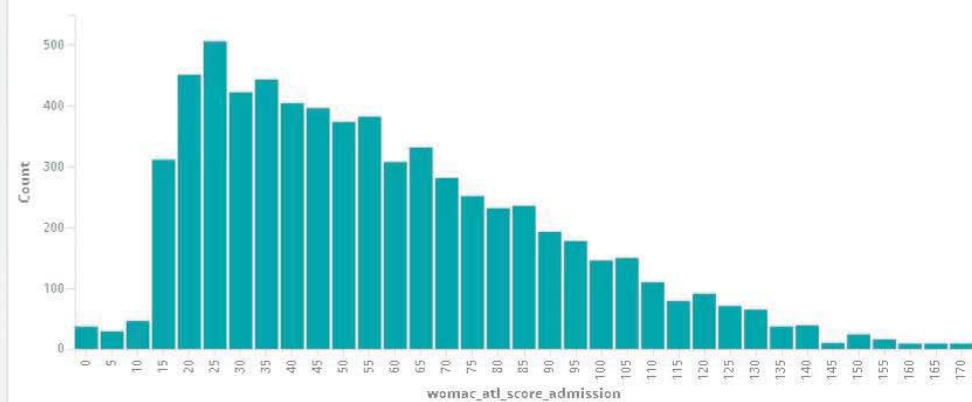
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Treemap showing the ICD10 diagnosis structure





Distribution of the WOMAC ATL Admission Score





 Discover


 Visualize

 **Dashboard**

 Timeline

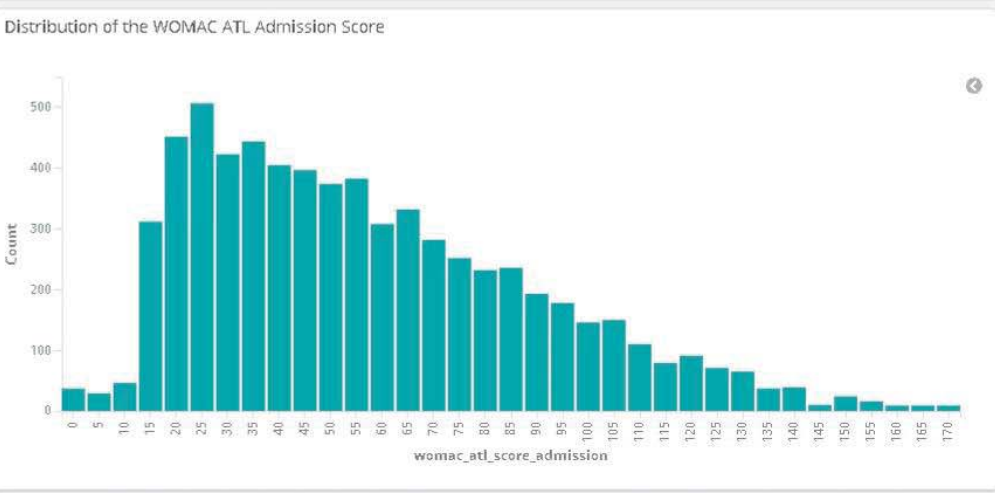
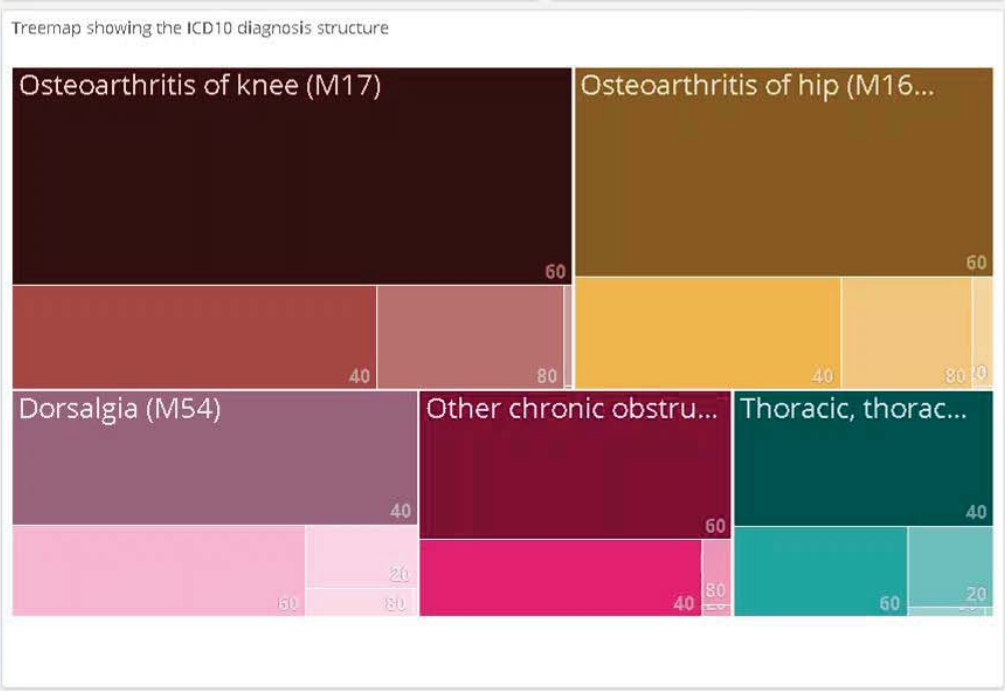
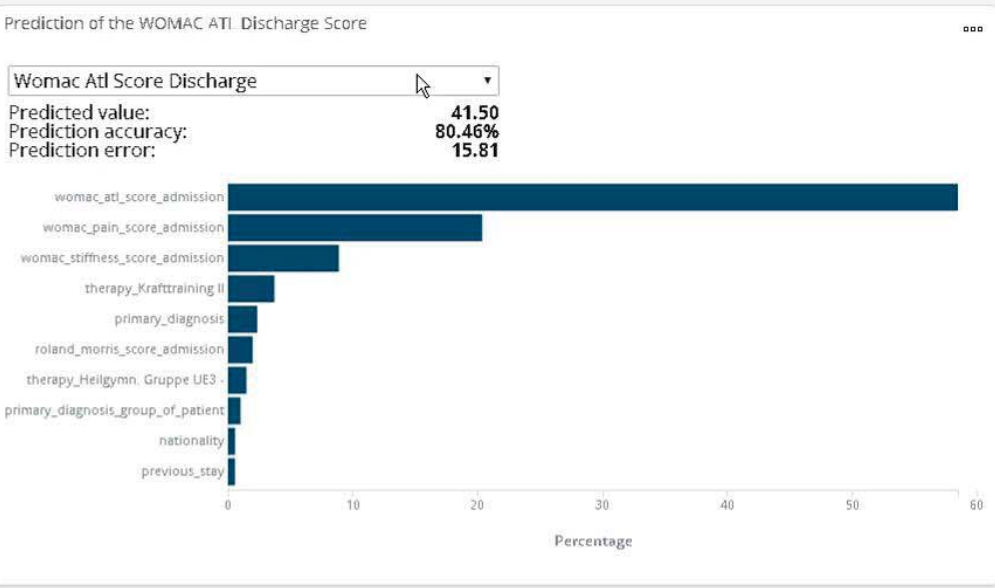
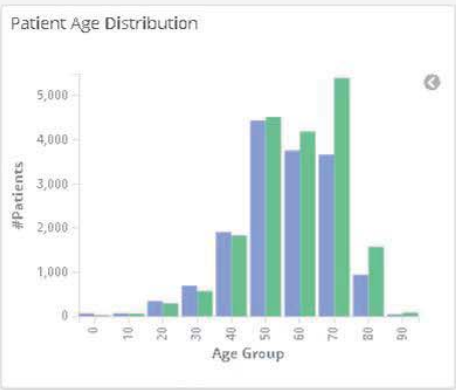
 Dev Tools

 Management

 Search Guard

Add a filter +

Filter



> Search... (e.g. status:200 AND extension:PHP)

Options

Refresh

Add a filter +

### Modify Therapy Minutes

therapy\_Krafttraining II



therapy\_TENS

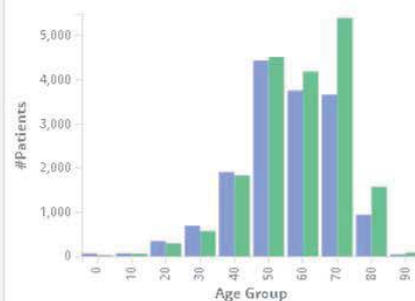


Clear form

Cancel changes

Apply changes

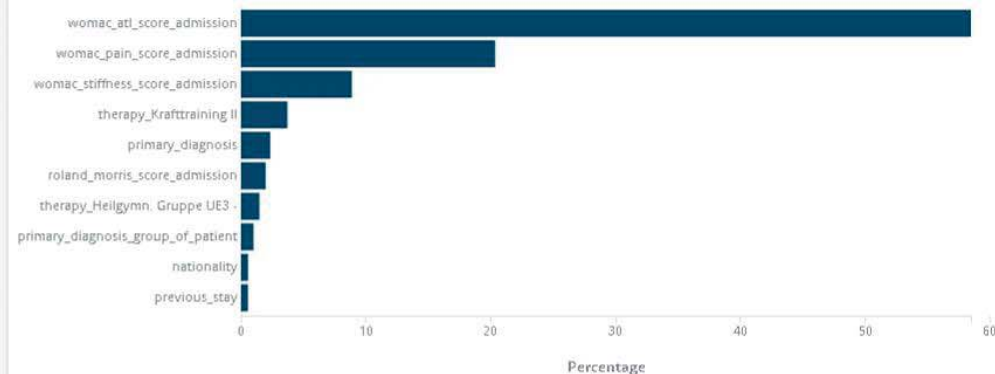
### Patient Age Distribution



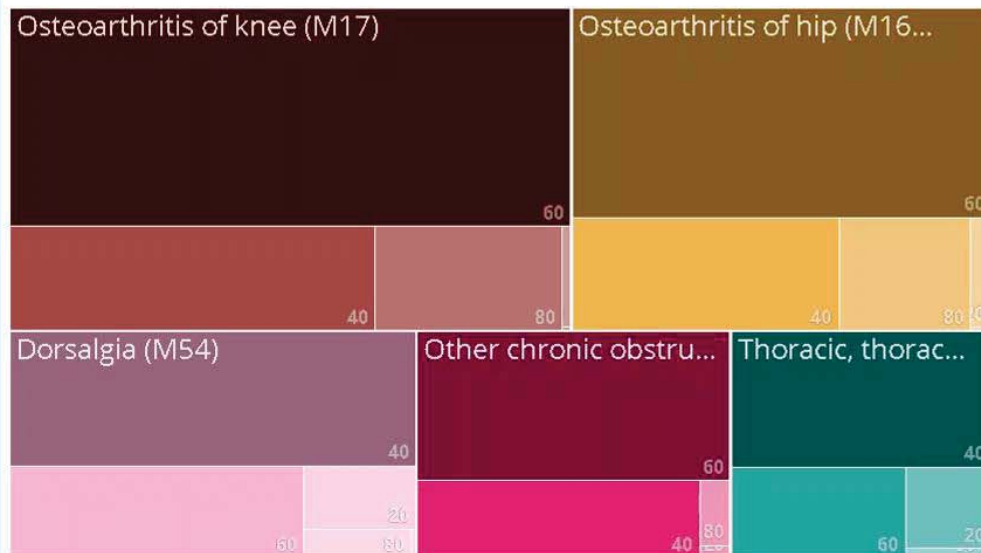
### Prediction of the WOMAC ATL Discharge Score

Womac Atl Score Discharge

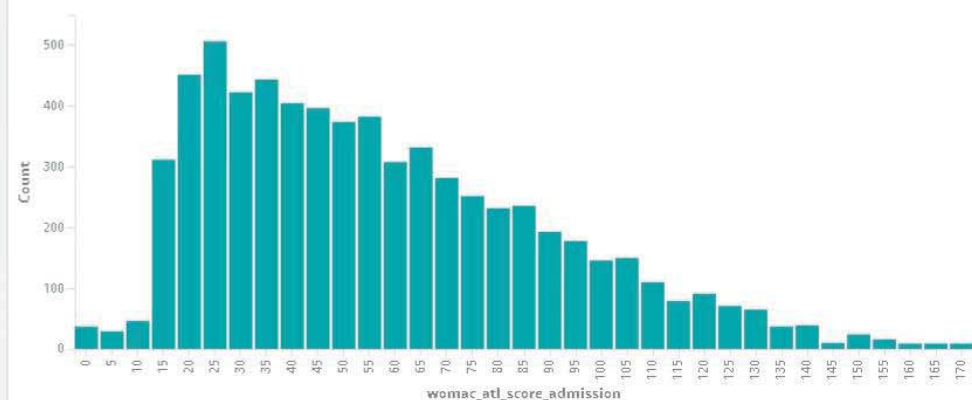
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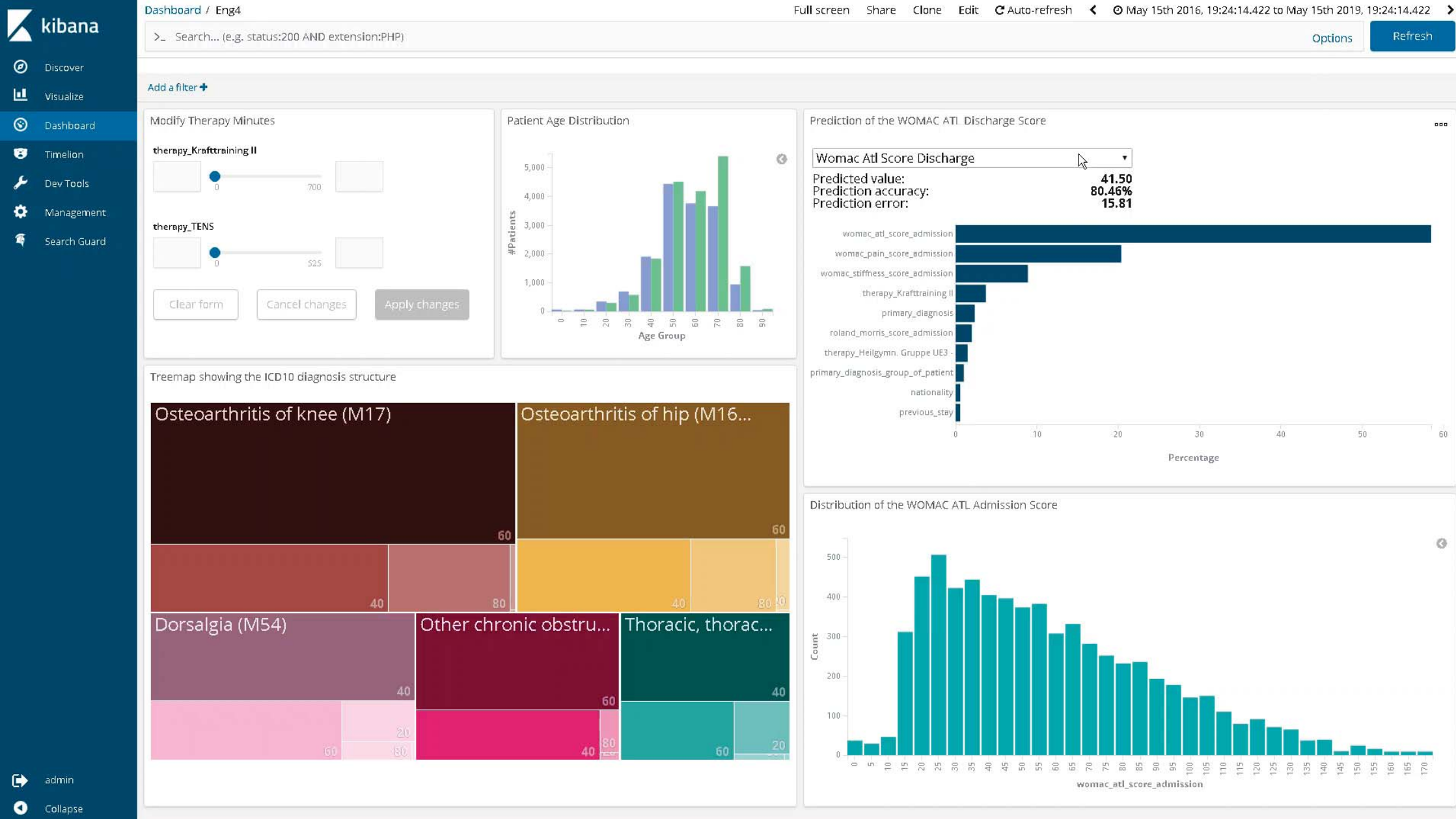


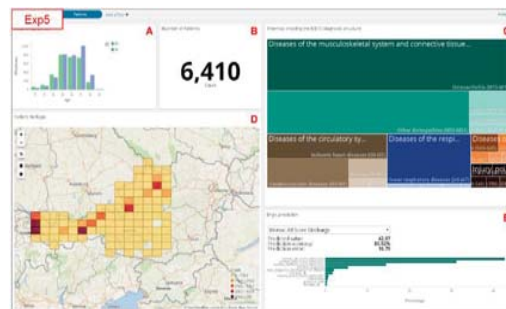
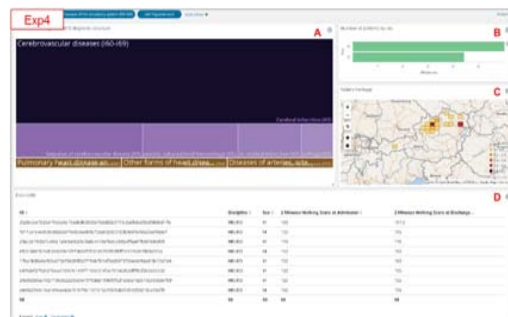
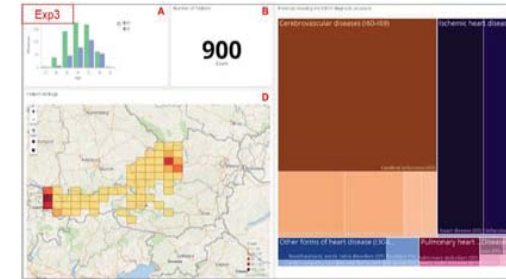
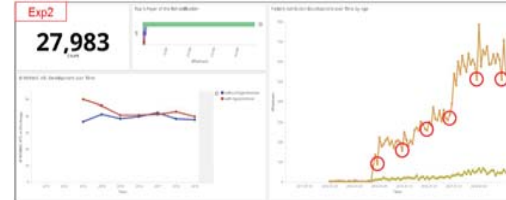
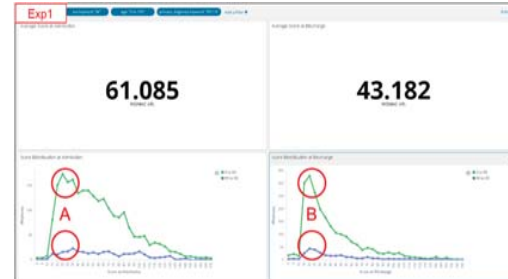
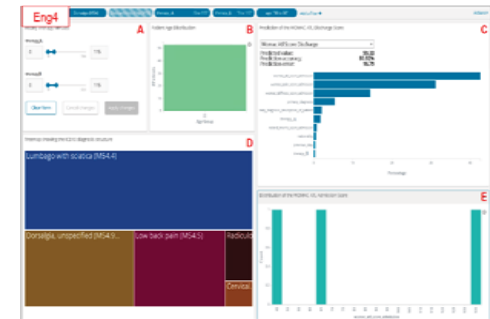
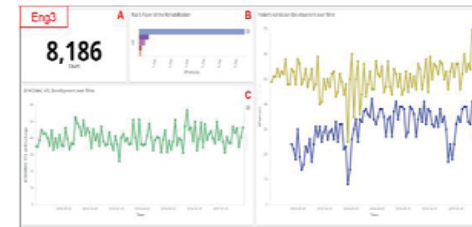
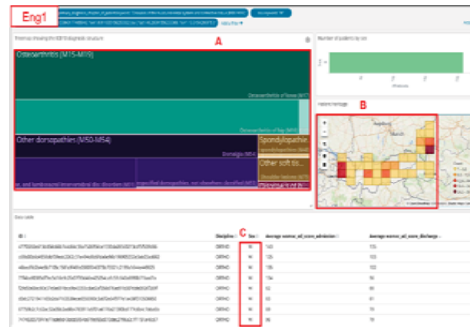
### Treemap showing the ICD10 diagnosis structure




### Distribution of the WOMAC ATL Admission Score







- Introduce **preha** to four potential users 
- Provide a set of small assignments to complete
- Findings:
  - (+) Flexibility, adaptability to own working style
  - (-) Documentation/language, more digestible for domain experts



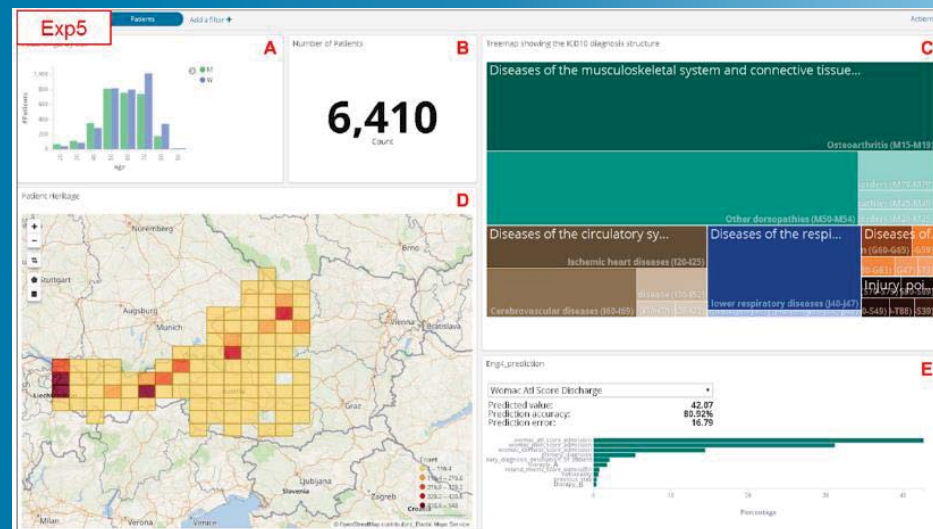
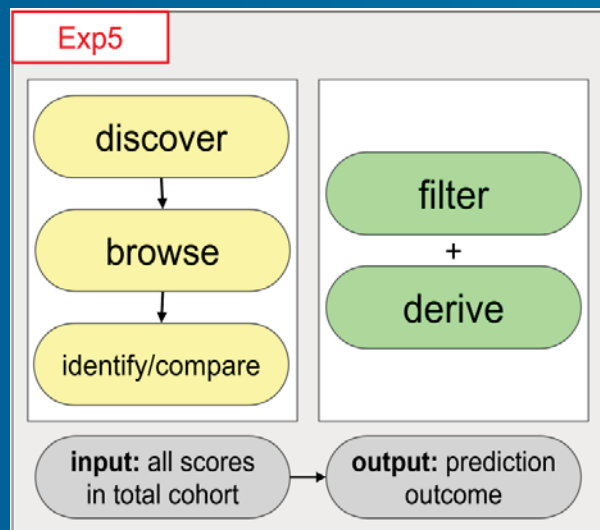
- **Design study** for the workflow of precision rehabilitation
- Development of a **dashboard-based strategy**
- Extend evaluation to domain experts
- Predictive analytics extension
- Guided analytics incorporation





# Thank You! Questions?

## preha



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