Process Mining in Personalized Healthcare
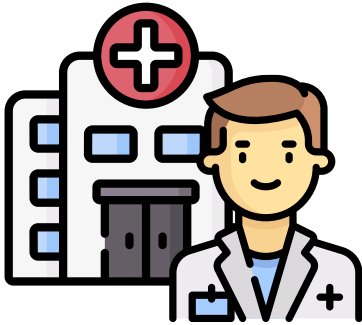
Master Project Prof. Weske – Winter Term 2019/20
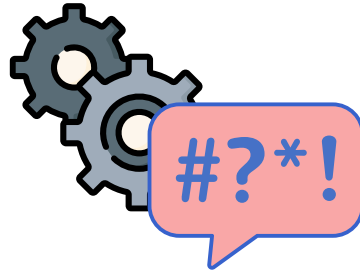**Finn Klessascheck, Simon Siegert, Tom Lichtenstein**

HPI·MS

An academic collaboration between the Hasso Plattner Institute and the Mount Sinai Health System

Processes in Hospitals
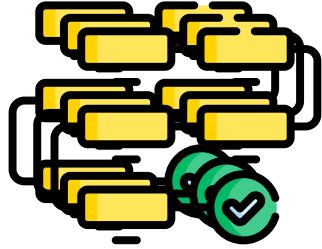
Conducted by
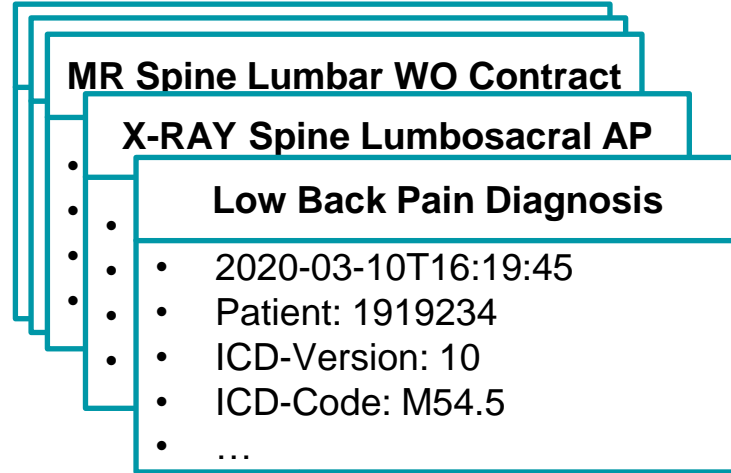medical experts

Diverse,
heterogeneous,
ad–hoc, complex

Actually impact
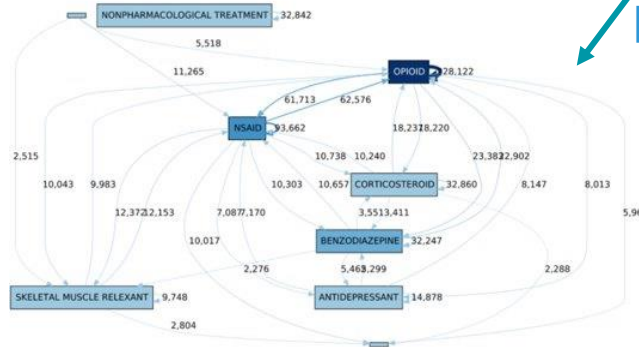physical wellbeing
of people!

Process Mining

Medical Process Instances

Events

MR Spine Lumbar WO Contract

X-RAY Spine Lumbosacral AP

Low Back Pain Diagnosis

- 2020-03-10T16:19:45
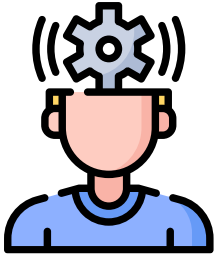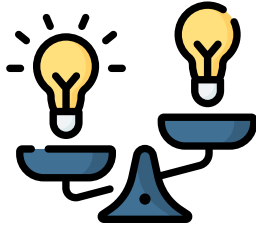- Patient: 1919234
- ICD-Version: 10
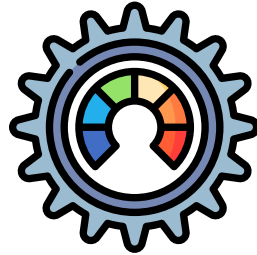- ICD-Code: M54.5
- …

[Process Mining]

Process Mining in Healthcare

Able to reason about actual treatment process

Compare actual with desired behaviour
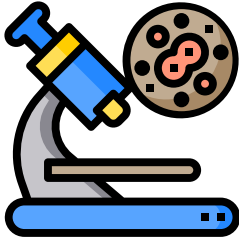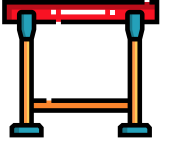
Monitor performance

Identify potential for improvement

Predict patient behaviour

Process Mining in Healthcare
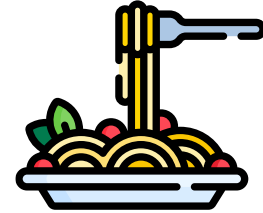
Low level events
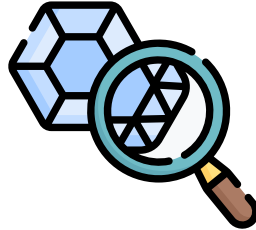
Data quality issues

Spaghetti models

Application Example

- Analysis of treatment processes at **Mount Sinai Hospital**
- Comparing process with guideline(s) from **American College of Physicians** [1]
- Use case: Non–specific **low back pain** [2]
  - Pathoanatomical cause unknown
  - Focus on pain treatment
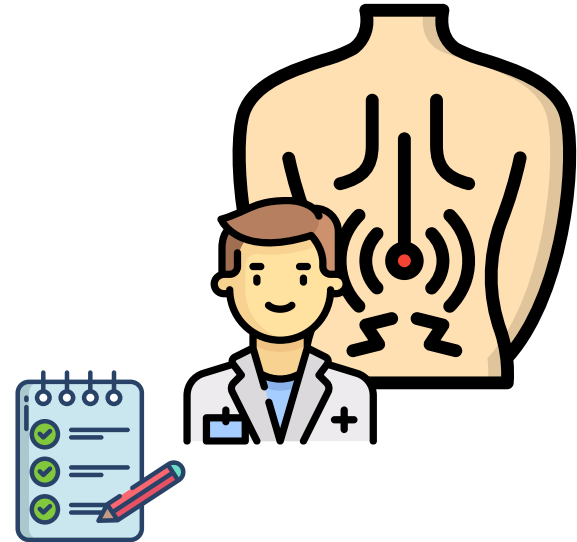
Application Example – Back Pain Treatment Process
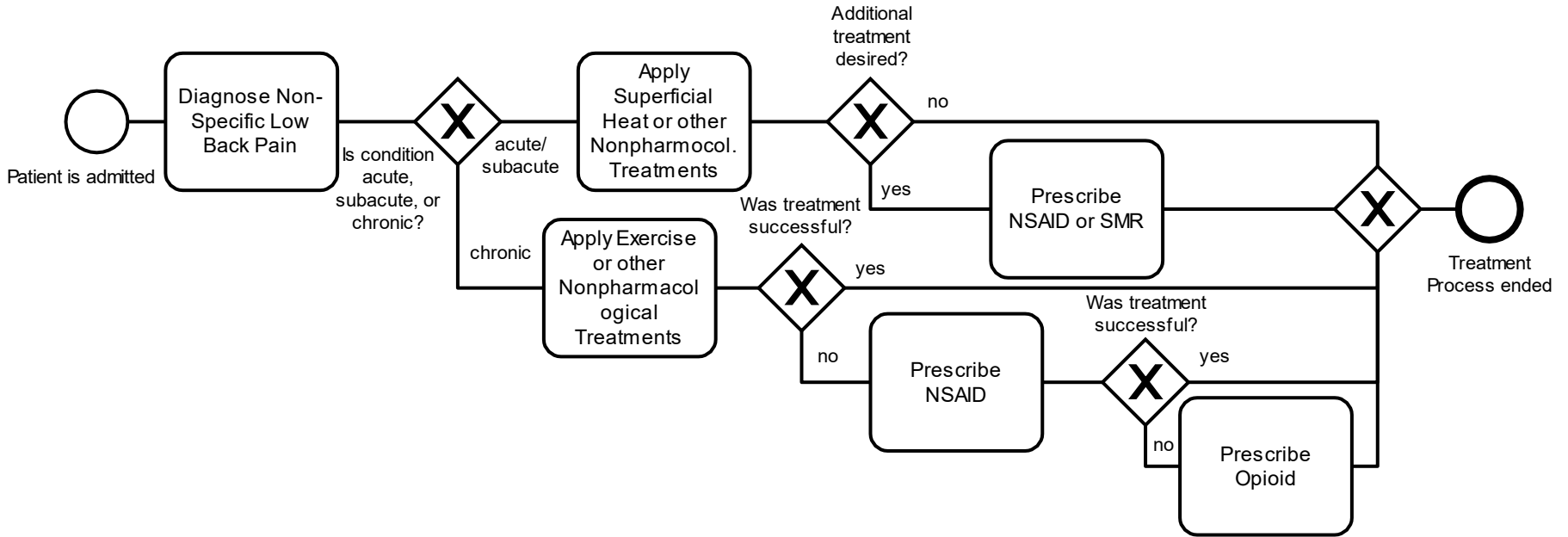
Application Example
– Back Pain Treatment Process

How do the treatment processes for low back pain at Mount Sinai look like from an event-perspective?
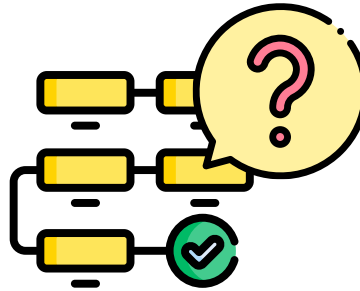
Mount Sinai Data Warehouse

- **SAP HANA** database in US
- **Fiber** tool from Prof. Böttinger's Group for Personalized Medicine simplifies data access
- Properties:
  - Size: ~ 160 GB
  - Patients: ~ 8 million
  - Encounters: > 137 million
  - Back pain patients: > 85.000
  - Back pain Patient Encounters: > 5 million

Star Topology

Materials — Diagnoses — Facts — Patients — Procedures — Encounters

Extraction Pipeline

~8 million patients

Fiber

Analyse
Medical Guideline

Access
Data Warehouse

Aggregate and
convert data
to **Event Log**

Discover Process
and
Check conformance

Low Back Pain

2 Types

Data Abstraction
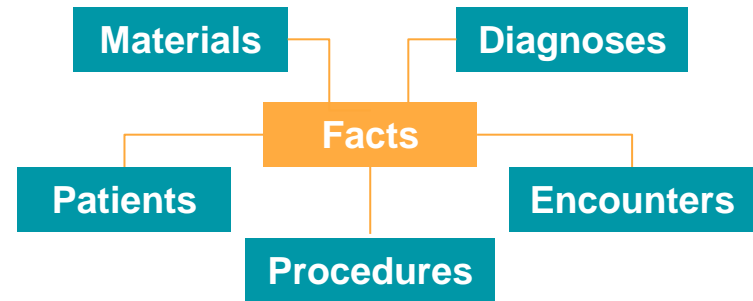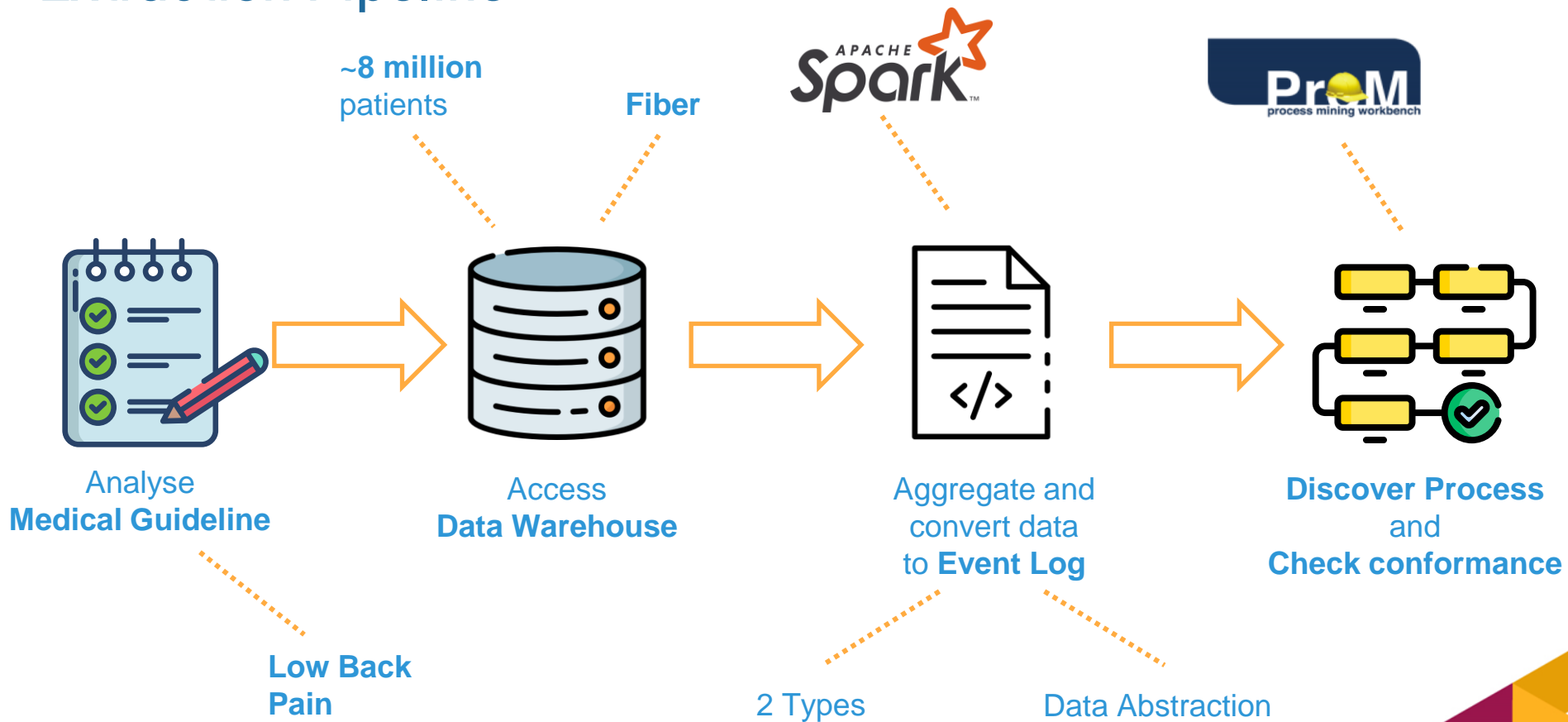
Two Types of Logs – MRN- and visit-based
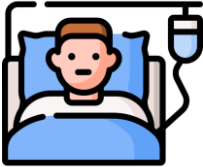
Medical Record Number
(MRN)

several visits

One trace for the **whole patient history**

A trace **for each hospital visit** of a patient

Process Mining in Healthcare
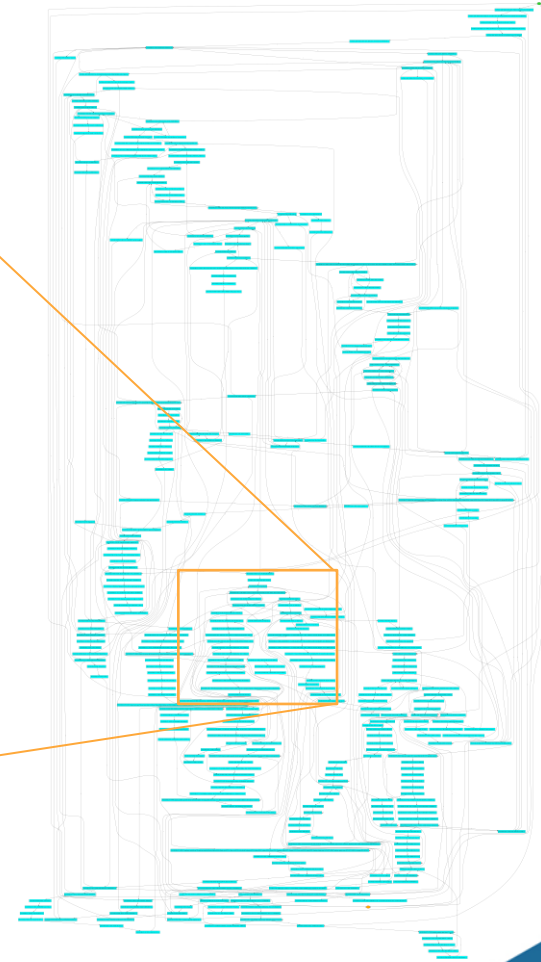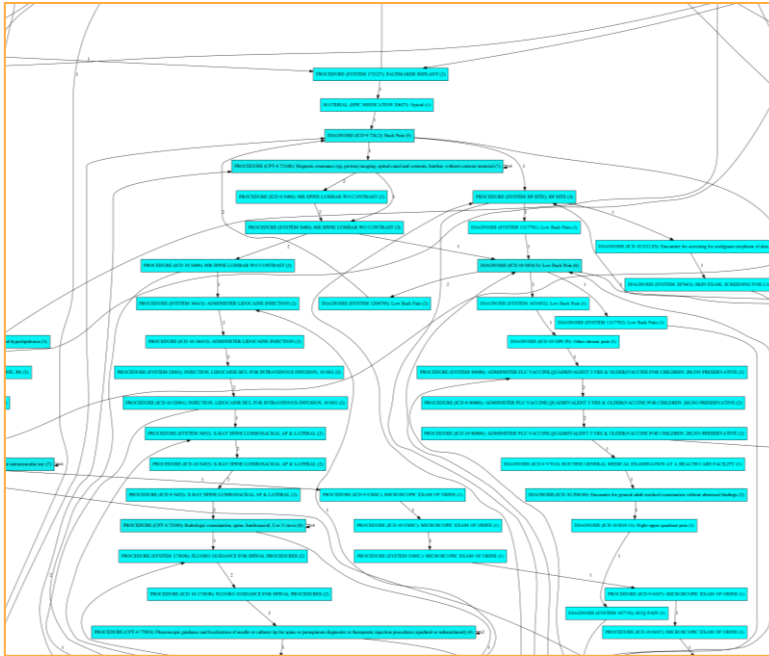
Cohort size: **4 Patients**
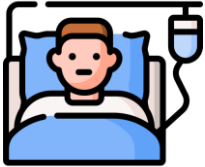Trace Type: MRN
Algorithm: Heuristic Miner (30 % DT)

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Ontology-based Abstraction

Event Log

Tramadol 100MG Tablet

- 2020-04-05T12:34:42
- Admission: 238423
- …

Yoga Therapy

- 2020-02-16T11:01:32
- Admission: 238423
- ICD-Version: 10-PCS
- ICD-Code: 8E0ZXY4
- …

Guideline

Opioid administered

- 2020-02-16T11:01:32

Nonpharmacological Treatment

- 2020-02-16T11:01:32

Ontology–based Abstraction

Event Log

Guideline

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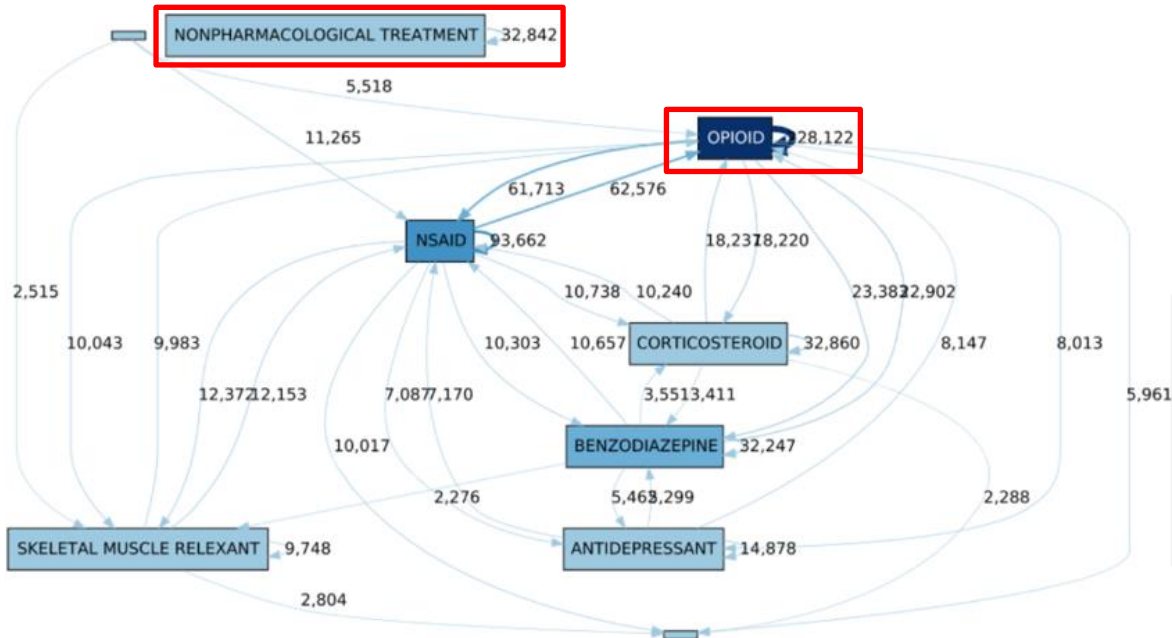
Case-specific
Medical Ontology

Opioid administered

- 2020-02-16T11:01:32

Nonpharmacological Treatment

- 2020-02-16T11:01:32

Ontology-based Abstraction

Abstracted Process – Ready for Analysis

Cohort size: ~30.000 patients

Lessons Learned

- Data adhering to medical standards simplifies cleansing and aggregation
- Abstraction & Pre-processing is highly use case-specific
- Conceptual questions require in-depth understanding of the use case and the data, as well as domain knowledge
- Event log types highly influence the conducted analysis
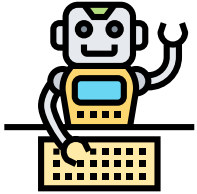- **Data itself is not enough**, it needs to be understood and interpreted as well!

Scientific Output

- Remy, Simon, et al. **"Event Log Generation in a Health System: A Case Study."** International Conference on Business Process Management. Springer, Cham, 2020.
- Klessascheck, Finn, et al. **"Domain-specific Event Abstraction"** (in review)

Future Work

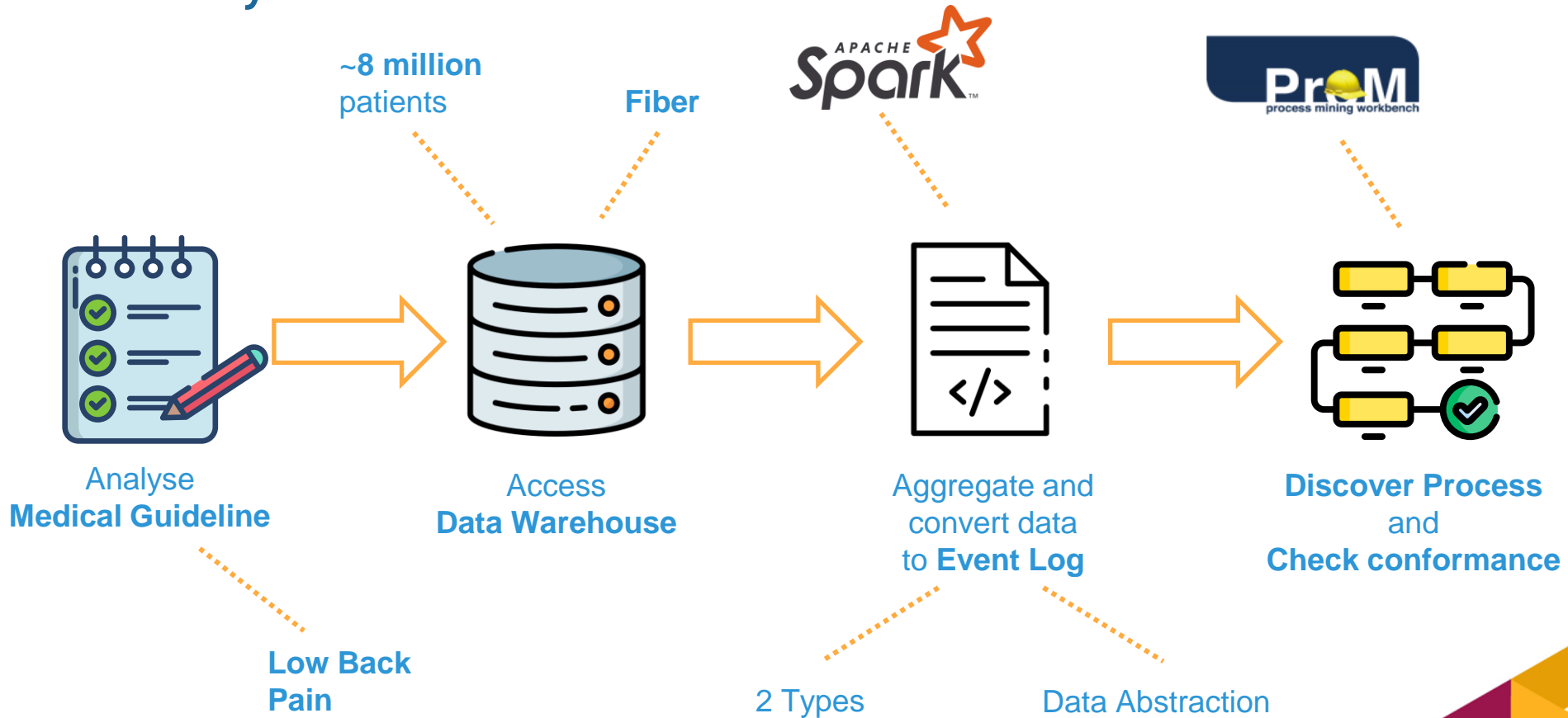Further increase **automation** of the approach to improve applicability

Integrate **unstructured information** (doctor's notes) and extract event information

Investigate other healthcare–related **use cases**

Summary

Sources

All icons used are from flaticon.com, licensed using a paid Premium Flaticon License.

[1] Qaseem, Amir, et al. "Noninvasive treatments for acute, subacute, and chronic low back pain: a clinical practice guideline from the American College of Physicians." Annals of internal medicine 166.7 (2017): 514–530.

[2] Maher, Chris, Martin Underwood, and Rachelle Buchbinder. "Non-specific low back pain." The Lancet 389.10070 (2017): 736–747.

[3] Chou, Roger, et al. "Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society." Annals of internal medicine 147.7 (2007): 478–491.