Case Study

Exam Call 18.12.2025 – Patient Treatment in Emergency Department

Description

In many large hospitals, especially those serving a high volume of patients Emergency Department (ED), the patient journey is a complex process. This journey involves patient arrival and initial assessment, clinical evaluation, execution of necessary clinical procedures, and finally patient discharge of referral. Efficient patient flow is critical to minimizing wait times, improving patient outcomes, and ensuring regulatory compliance.

The goal of this case study is to analyze the end-to-end patient treatment process to identify structural inefficiencies, assess conformance, and propose data-driven improvements.

A case in the context of an ED process represents a single patient stay in the ED, uniquely identified by a `stay_id`. An event refers to the execution of a specific activity (`activity`) within that stay. and its precise time of occurrence, recorded in `timestamp`.

The dataset includes case-level attributes, which remain constant across all activities, such as arrival mode (`arrival_transport`), disposition (`disposition`), `gender`, `race`, `acuity` (urgency level assigned at triage) and diagnostic codes (`diagnosis_code`).

In addition, the dataset includes a set of event-level attributes, which describe information specific to each individual event. They include information on physiological measurements (such as temperature, heart rate, and respiratory rate), records of administered medications, as well as identifiers of the clinical staff involved in performing specific procedures

The event log is anonymised but not public. It can be used for the exam, but not for any other purpose. It can be downloaded from the Ariel Platform in the 'Teaching materials' section.

In the Appendix, you can find the medical ranges for the physical measurements. You may use them in your analysis, though their use is optional.

Assignment

Describe the **Knowledge Uplift Trail** that allows you to provide answers to the analytical goals regarding the patient treatment process.

In particular, define and justify the steps required for a complete process analysis:

1. **Build a preprocessing pipeline for cleaning** (e.g., handling missing data) **and filtering dataset** (e.g., remove noise)
2. **Perform a performance analysis of the event log.**
3. **Discover process models from the log** and perform **conformance checking**.
4. **Identify potential improvements.**

5. **(Additional question)** In process mining, we often want to group similar cases into variants - not only based on the order of activities but also based on the meaningful case or event attributes such as age, diagnosis, or patient condition.

   One approach to do this is through **pattern-based feature generation**, where we define a set of properties (e.g., "age ≥ 50", or "diagnosis = heart failure") and encode each event sequence with a binary vector that indicates whether or not it satisfies each property.

   This encoding is done using a binary mapping function φ, which maps each event sequence to a vector of 0s and 1s - where each 1 means the property is present in the case, and 0 means it is not.

   Example:

STAY_ID	AGE	TEMP	P1 (AGE ≥ 65)	P2 (TEMP ≥ 38.0)	VARIANT
A	72	38.5	1	1	*V11 (1,1): older + fever*
B	34	37.0	0	0	*V00 (0,0): younger + no fever*
C	81	36.9	1	0	*V10 (1,0): older + no fever*
D	22	38.1	0	1	*V01 (0,1): younger + fever*

Propose a method for performing variant analysis using pattern-based feature generation for our dataset. How can this method help to identify improvements? Suggest some options.

APPENDIX

Parameter	Normal (Healthy) Range	Abnormal Values
Temperature (temperature)	97.8–99.1°F	Fever ≥ 100°F
Heart rate (heartrate)	60–100 bpm	> 100 bpm
Respiratory rate (resprate)	12–20 breaths/min	> 20 = tachypnea
Oxygen saturation (o2sat)	95–100%	< 90% = hypoxemia
Systolic BP (sbp)	90–120 mmHg	> 120 mmHg
Diastolic BP (dbp)	60–80 mmHg	> 80 mmHg
Pain (pain)	0	> 0
Rhythm (rhythm)	Sinus rhythm	Not sinus rhythm
Acuity (acuity)	Low (e.g., 4 or 5 in ESI)	1–3