MEDINFO23

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From Healthcare Data to Process Analytics

Daniel Capurro[1], Abel Armas-Cervantes[1], Eric Rojas[2]

(1) University of Melbourne, (2) Pontificia Universidad Católica de Chile

Agenda for today

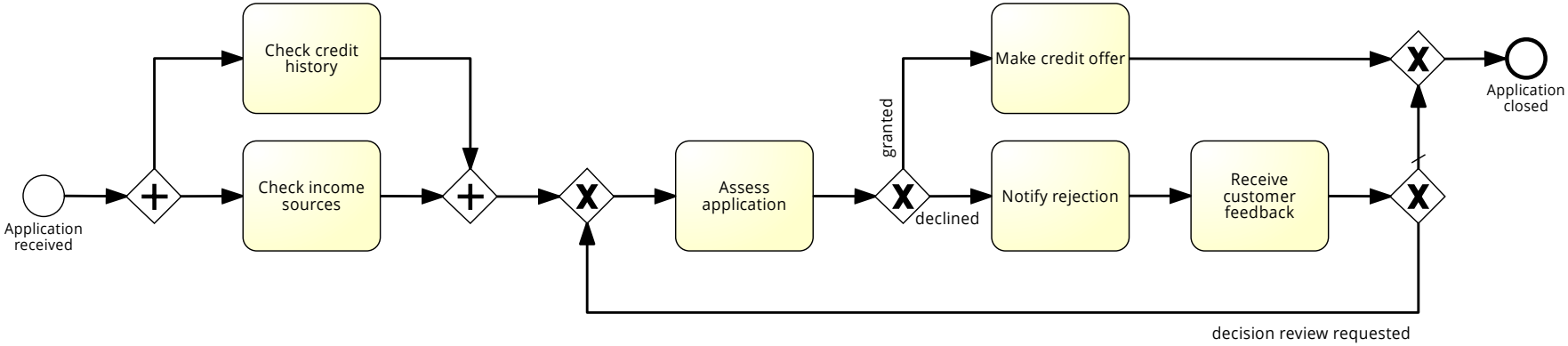
- Process mining methods (Dr. Abel Armas-Cervantes)
- Clinical data from a process perspective (A/Prof Daniel Capurro)
- Clinical process mining use cases (Dr. Eric Rojas)
- Q and A

Process Mining Methods

What is a business process?

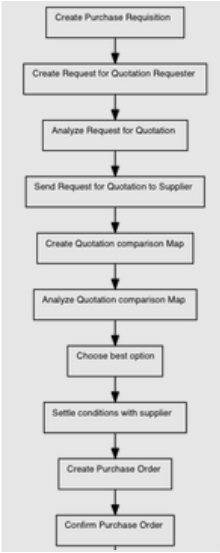
Collection of inter-related ***events***, ***activities*** *and* ***decision points*** *that involve a number of* ***actors*** *and* ***objects***, *and that collectively* ***lead to an outcome that is of value to at least one customer***

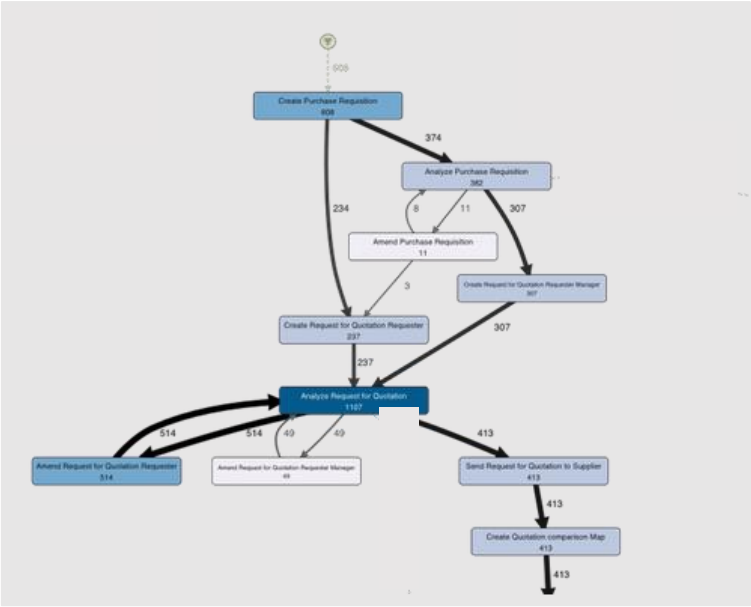
How to represent a process?



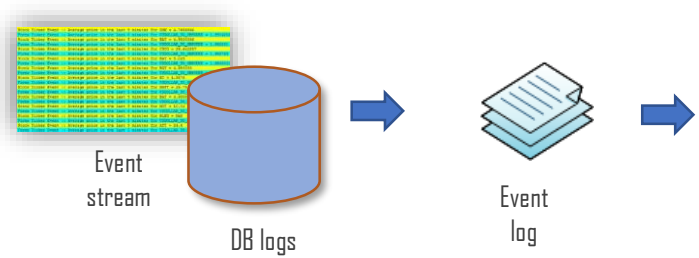
Life after modelling

Expectation vs reality

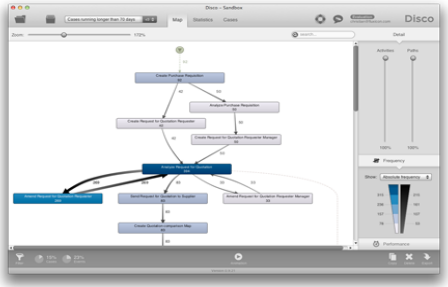




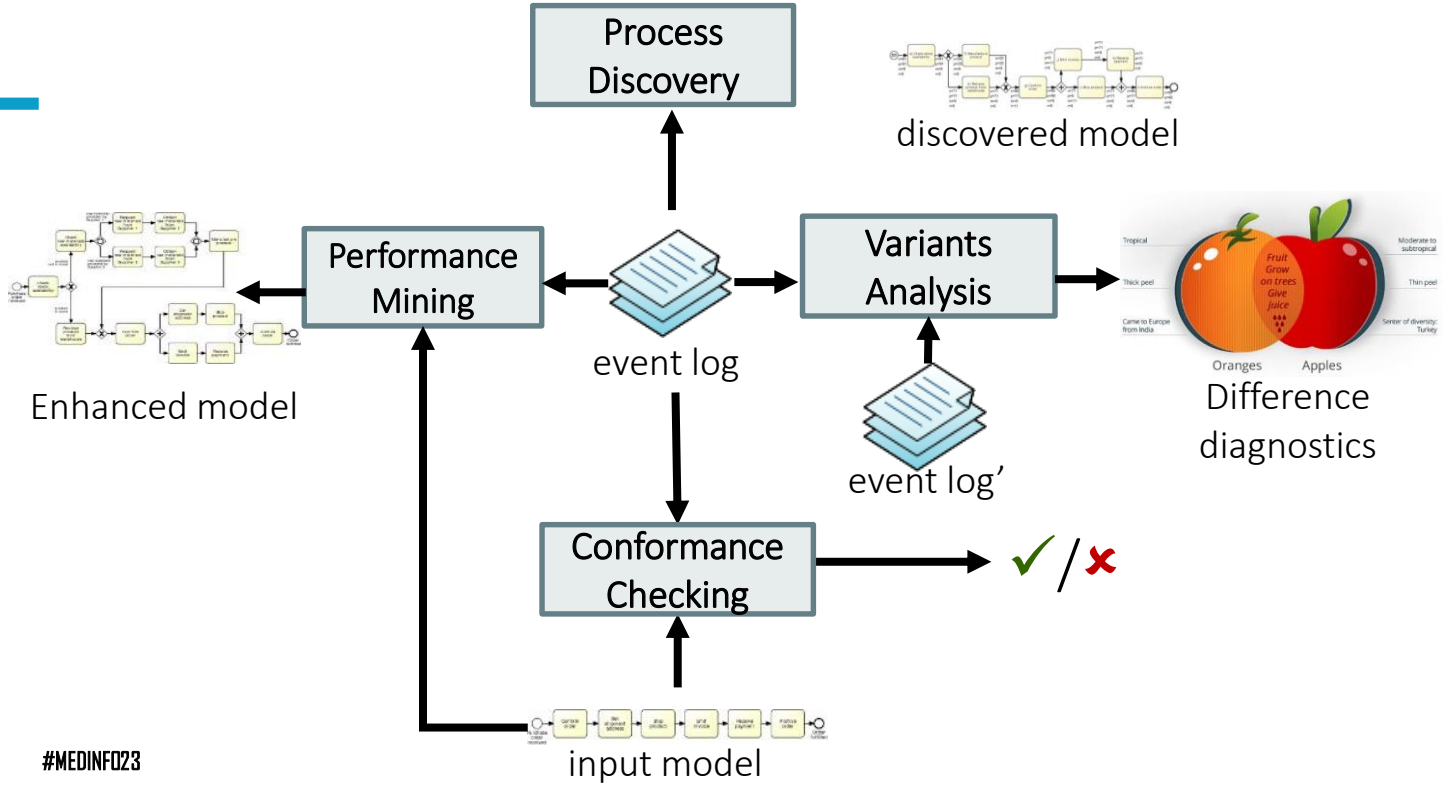
Process mining



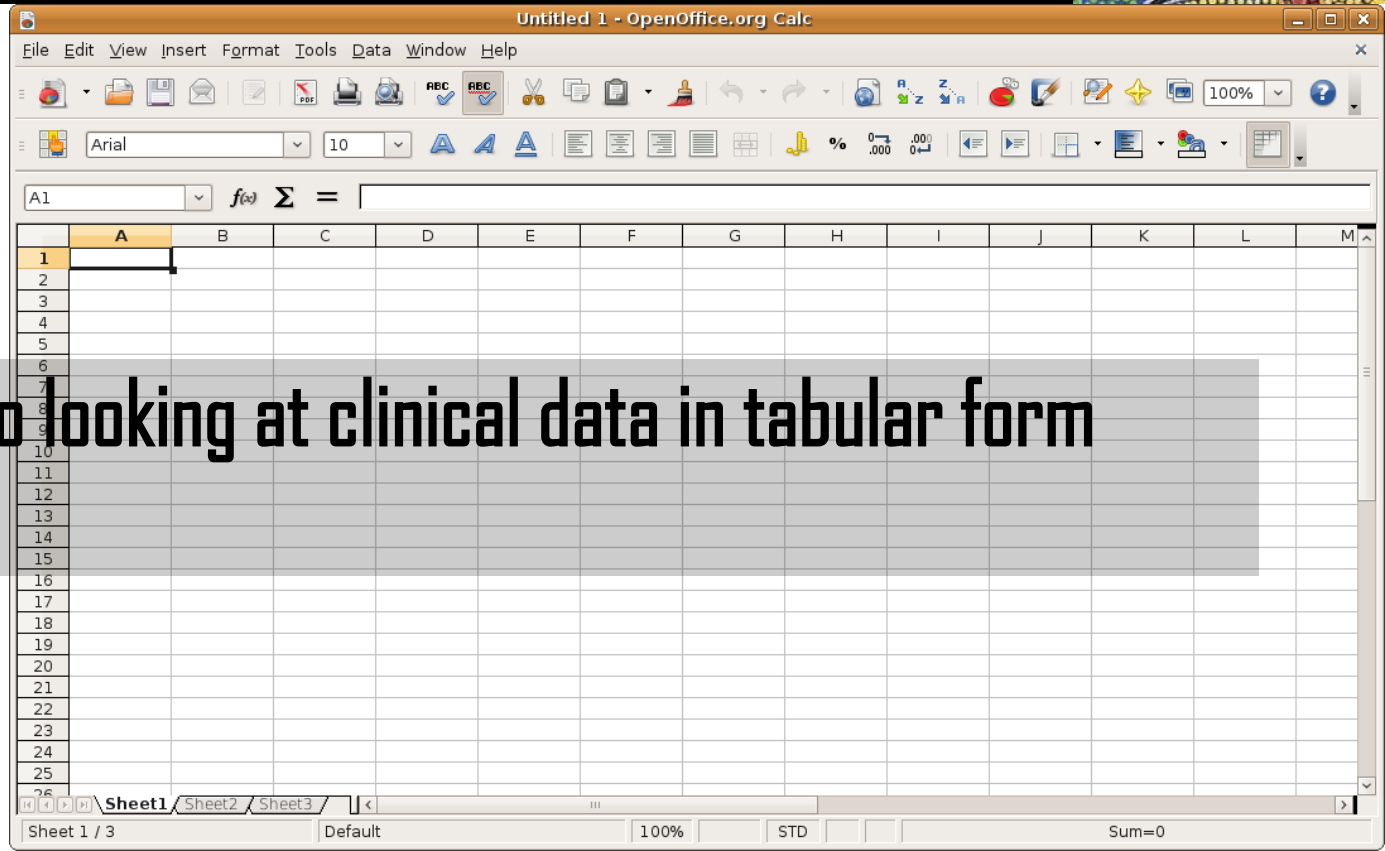
Process mining



Process mining is a family of methods for analyzing business processes based on event logs

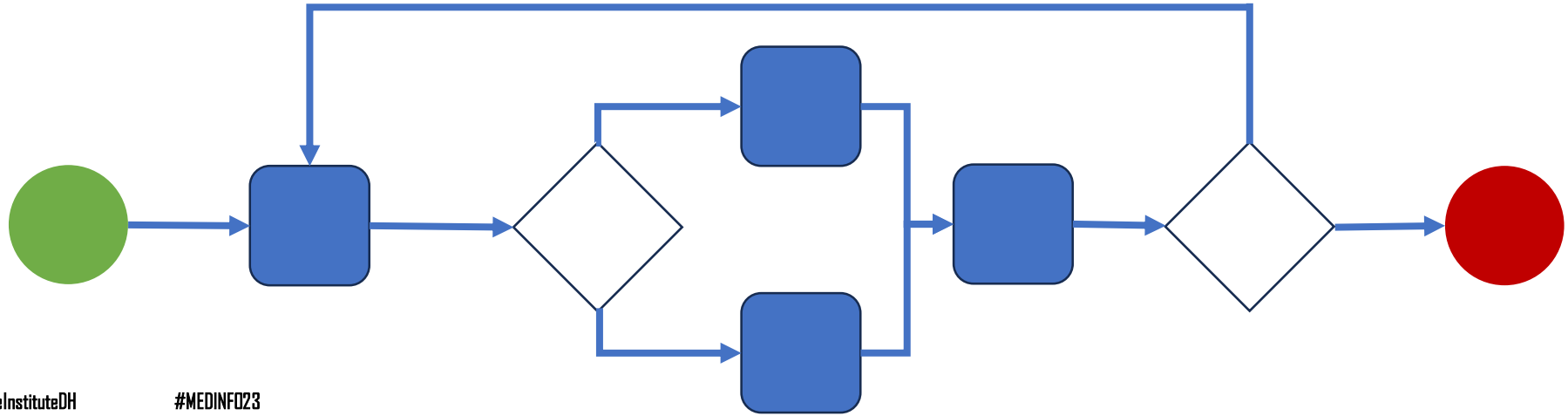

Process Discovery
discovered model
Performance Mining
Enhanced model
event log
Variants Analysis
event log'
Difference diagnostics
Conformance Checking
✓/✗
input model

Clinical Data from a Process Perspective

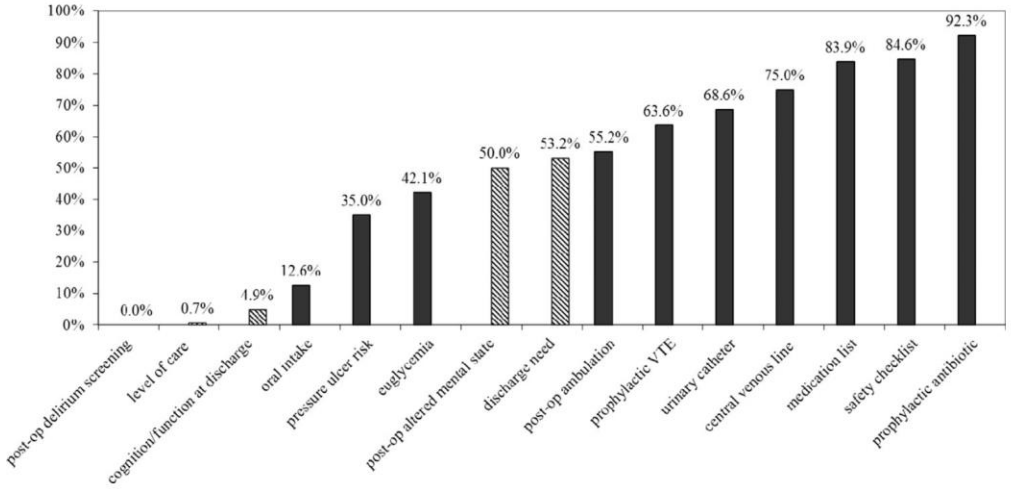


We are used to looking at clinical data in tabular form

But delivering healthcare is not a collection of isolated interventions but sequences of tasks and decision points



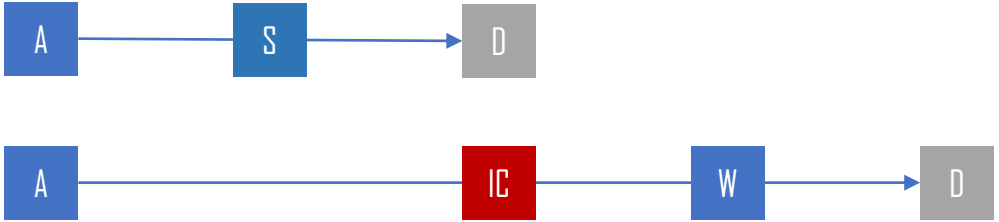
We know that adherence to recommended processes is not ideal



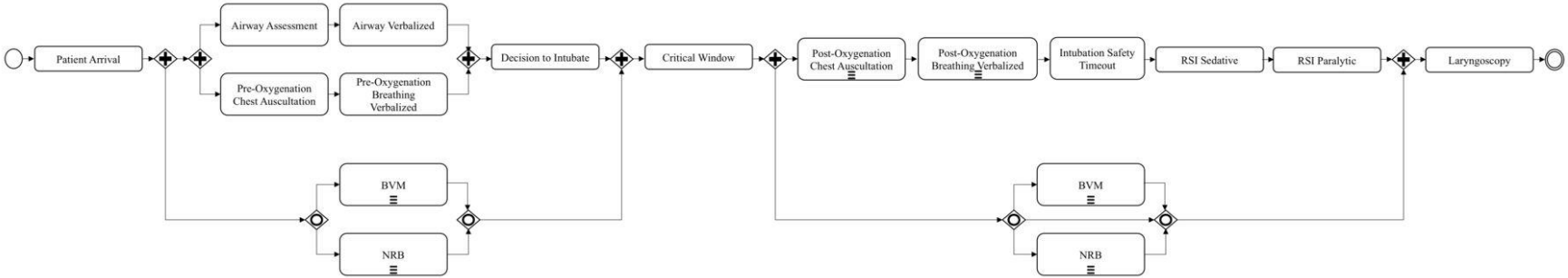
Bergman S, Martelli V, Monette M, Sourial N, Deban M, Hamadani F, Teasdale D, Holcroft C, Zakrzewski H, Fraser S. Identification of quality of care deficiencies in elderly surgical patients by measuring adherence to process-based quality indicators. Journal of the American College of Surgeons. 2013 Nov 1;217(5):858-66.

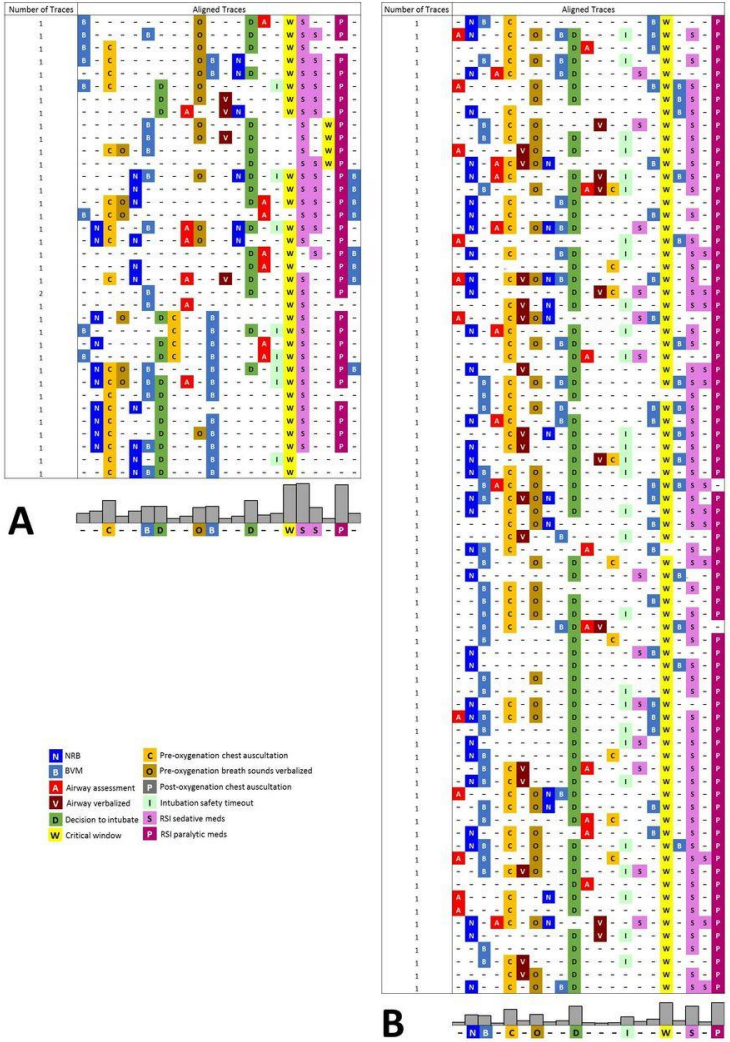
Case ID	Event	Timestamp	Resource	Attribute
1	Admission	1/1/2020 @ 08:00	Admission Clerk	Admission Desk
1	Surgery	1/1/2020 @ 08:30	Doctor 1	Operating Room
2	Admission	1/1/2020 @ 08:02	Admission Clerk	Admission Desk
1	Discharge	2/1/2020 @ 11:46	Nurse 1	General Ward
2	ICU Transfer	2/1/2020 @ 03:50	Doctor 2	Medical ICU
2	Ward Transfer	5/1/2020 @ 09:15	Doctor 1	Medical Ward
2	Discharge	7/1/2020 @ 14:40	Nurse 2	Medical Ward

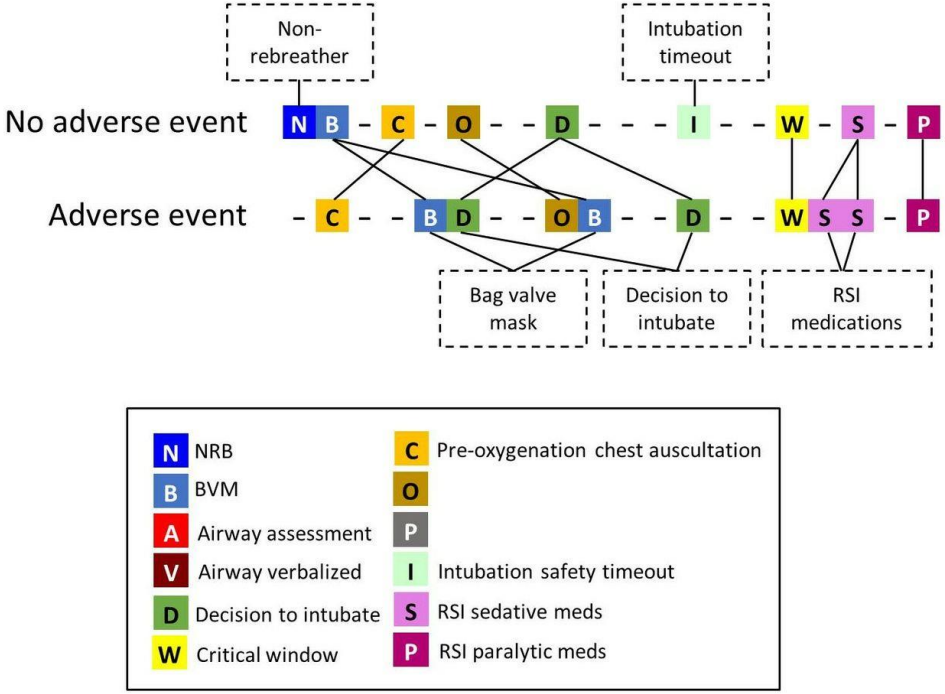
Trace



One example


Patient Arrival
Airway Assessment
Airway Verbalized
Pre-Oxygenation Chest Auscultation
Pre-Oxygenation Breathing Verbalized
Decision to Intubate
Critical Window
Post-Oxygenation Chest Auscultation
Post-Oxygenation Breathing Verbalized
Intubation Safety Timeout
RSI Sedative
RSI Paralytic
Laryngoscopy
BVM
NRB
BVM
NRB





O'Connell KJ, Yang S, Cheng M, *et al.* Process conformance is associated with successful first intubation attempt and lower odds of adverse events in a paediatric emergency setting. *Emergency Medicine Journal* 2019;**36**:520-528.

Clinical Process Mining Use Cases

Clinical Process Mining Use Cases

Use Cases

- Emergency Room Process
- Patients with type 2 Diabetes Mellitus

Emergency Room Process

Red de Salud UC · CHRISTUS. Santiago, Chile.

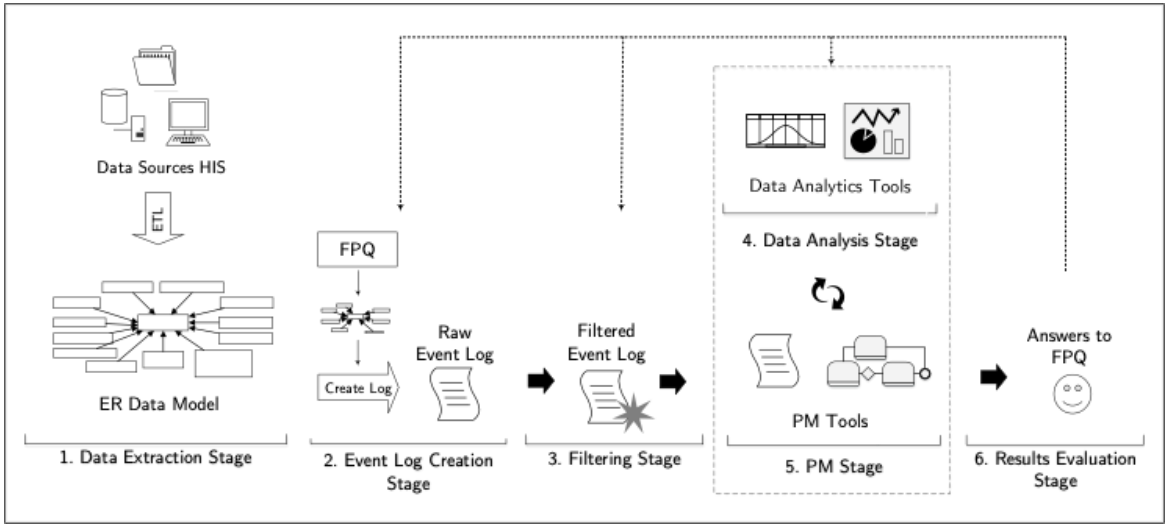
- 11 medical centres
- 1000 doctors and 4000 professionals

Healthcare attention and medical education

Data:

- HIS Alert ADW Phase I
- January to July 2014
- 39.003 episodes
- 1.754.000 events

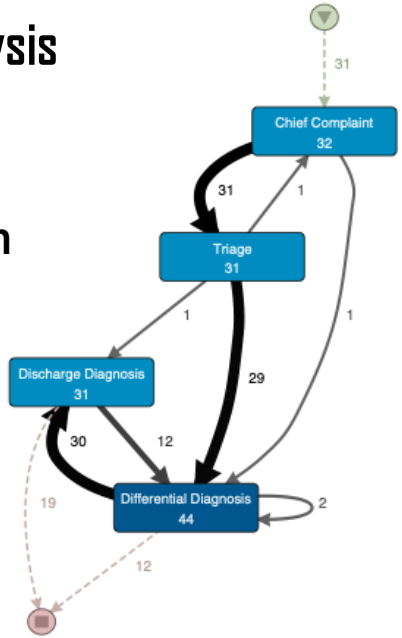
Question-Driven Methodology for Analyzing Emergency Room Processes



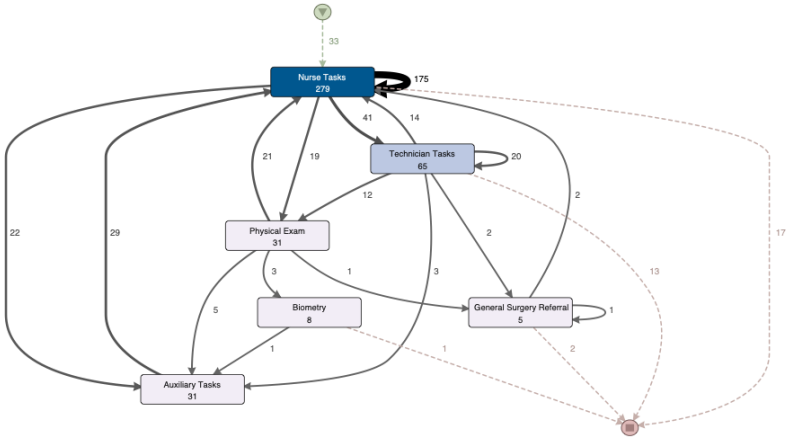
Rojas, E., Sepúlveda, M., Munoz-Gama, J., Capurro, D., Traver, V., & Fernandez-Llatas, C. (2017). Question-Driven Methodology for Analyzing Emergency Roo
Processes Using Process Mining. Applied Sciences, 7(3), 302.

Discovery or Control Flow Analysis

What activities are carried out and what process is followed in providing attention to ER patients diagnosed with appendicitis?



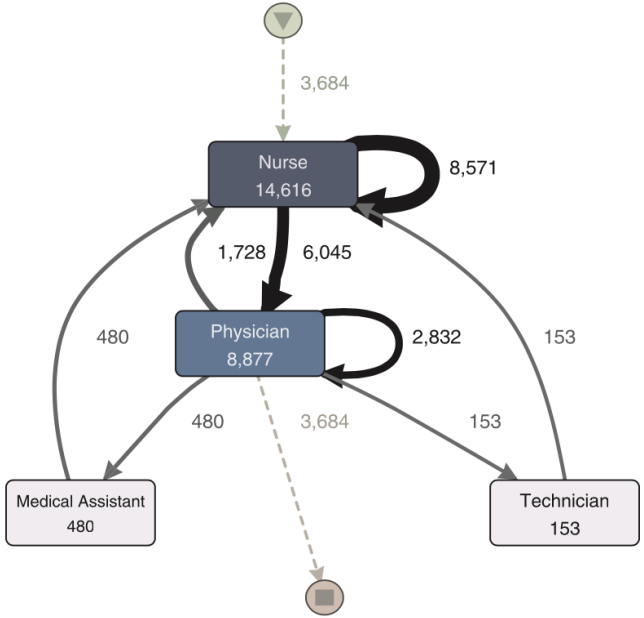
Triage and Diagnosis sub process

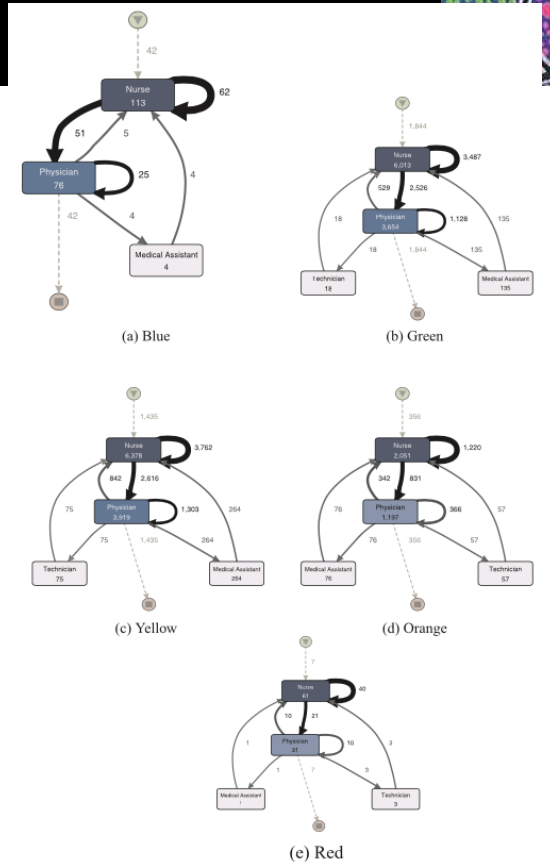


Examination sub process

Alvarez, C., Rojas, E., Arias, M., Munoz-Gama, J., Sepúlveda, M., Herskovic, V., & Capurro, D. (2018). Discovering role interaction models in the Emergency Room using Process Mining. *Journal of biomedical informatics*, *78*, 60-77.

Organizational Analysis – Rol Patterns





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Patients with type 2 Diabetes Mellitus: Collaboration Patterns

Physician, Nurse, and Dietitian Collaboration Patterns

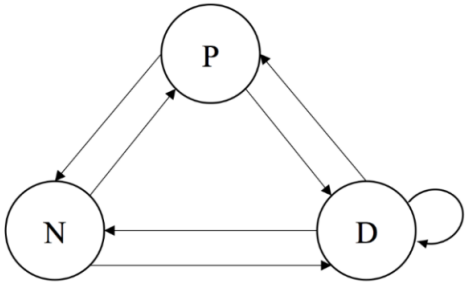
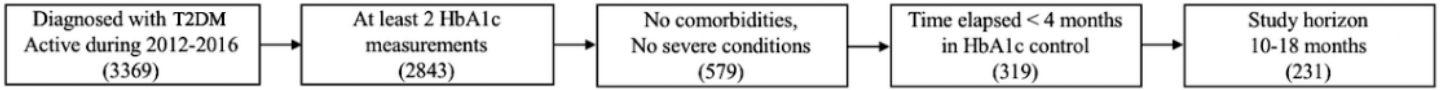


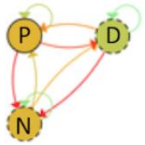
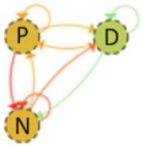
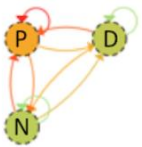
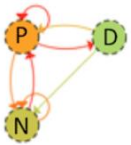
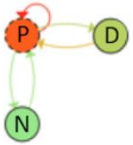
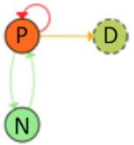
Figure 1. Criteria applied during patient selection process. T2DM: type 2 diabetes mellitus; HbA_{1c}: glycated hemoglobin.



Conca, T., Saint-Pierre, C., Herskovic, V., Sepúlveda, M., Capurro, D., Prieto, F., & Fernandez-Llatas, C. (2018). Multidisciplinary collaboration in the treatment of patients with type 2 diabetes in primary care: analysis using process mining. *Journal of medical Internet research*, *20*(4), e8884.

Patients with type 2 Diabetes Mellitus: Collaboration Patterns

Models with One Node		
Name	Model K	Model L
Diagram		

Models with Three Nodes						
Name	Model A	Model B	Model C	Model D	Model E	Model F
Diagram						

Models with Two Nodes				
Name	Model G	Model H	Model I	Model J
Diagram				

P = Physician,
N = Nurse, and
D = Dietitian
Collaboration Patterns

Conca, T., Saint-Pierre, C., Herskovic, V., Sepúlveda, M., Capurro, D., Prieto, F., & Fernandez-Llatas, C. (2018). Multidisciplinary collaboration in the treatment of patients with type 2 diabetes in primary care: analysis using process mining. *Journal of medical Internet research*, *20*(4), e8884.

Challenges for future Case Studies

- Frameworks developed for use in health in general and in telemedicine.
- Record more information about the process and not just the use of the tools.
- How to combine with other data analytics techniques.
- Data Quality for process analytics.
- Privacy and security aspects.
- Incorporate the patient's vision in the process.
- Make it an iterative and periodic process.

Munoz-Gama, J., Martin, N., Fernandez-Llatas, C., Johnson, O. A., Sepúlveda, M., Helm, E., ... & Zerbato, F. (2022). Process mining for healthcare: Characteristics and challenges. *Journal of Biomedical Informatics*, *127*, 103994.