Brainstorm seminar: Enhancing the usability and understandability of process mining in healthcare

Program
27-28 June 2019

An initiative of the Process-Oriented Data Science for Healthcare Alliance *(www.pods4h.com)*, supported by the Scientific Research Community on Process Mining *(www.srcprocessmining.com)*

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About the seminar

The healthcare sector in general, and hospitals in particular, are confronted with enormous challenges such as tightening budgets contrasted to increased care needs due to an aging population. To face these challenges, hospitals are aware of the need to analyze their processes in order to improve them. In this respect, process mining has great potential to gain thorough insights in processes. Despite this potential, the uptake of process mining in the healthcare sector outside the research context is rather limited.

Given this observation, this brainstorm seminar focuses on the **usability and understandability of process mining in the healthcare sector**. It aims to determine which additional research paths need to be explored or which mindset is required amongst process mining researchers to enhance the use of process mining in healthcare. Which efforts are still required to use process mining to support the deployment of value-based healthcare? Moreover, the implications of recent technological advances such as the evolution towards Healthcare 4.0 will be discussed. Will Healthcare 4.0 increase the use of process mining and what additional challenges will it impose?

The two-day seminar will encompass several thematic sessions during which different facets of this topic are discussed. In this way, interesting directions for future research can be identified. Based on the discussions during the brainstorm seminar, a position paper on the seminar's topic is envisioned. Besides the position paper, the brainstorm seminar also aims to initiate research collaborations on specific topics between the attendees.

Organization

The brainstorm seminar is an initiative of the Process-Oriented Data Science for Healthcare Alliance, supported by the Scientific Research Community on Process Mining.

The **Process-Oriented Data Science for Healthcare Alliance** aims to create opportunities for training, cooperation and knowledge sharing among multidisciplinary stakeholders with respect to the use of process-oriented data science technologies in the healthcare domain. In this way, the alliance aims to solve the barriers for its applicability, enforce the development of tools, present methods and algorithms that fit the real needs of healthcare professionals, and define methodologies and frameworks that encourage an adequate application of process-oriented data science in healthcare. More information on the alliance can be found on www.pods4h.com.

The **Scientific Research Community on Process Mining** aims to interchange research ideas and aspires synergetic research collaborations all over the world. The focus of the community's research efforts is to close the gap between scientific research on process mining techniques on one hand and the usability of these techniques on the other hand. More specifically, three challenges will be addressed:

- Challenge #1 – Improving usability and understandability for non-experts
- Challenge #2 – Understanding and reducing the representational bias in process discovery
- Challenge #3 – Improving the metrics to measure the quality of process discovery algorithms

More information on the research community can be found on www.srcprocessmining.com.

Central contact person

In case any issue would occur during the seminar, don't hesitate to contact the seminar's organizer:

dr. Niels Martin
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Seminar participants

Researchers

Name	Institution
Jochen De Weerdt	KU Leuven (Belgium)
Carlos Fernandez-Llatas	Universitat Politècnica de Valencia (Spain)
Avigdor Gal	Technion – Israel Institute of Technology (Israel)
Roberto Gatta	Centre Hopitalier Universitaire de Vaudois (Switzerland), Università degli Studi di Brescia (Italy)
Gema Ibáñez	Universitat Politècnica de Valencia (Spain)
Owen Johnson	Leeds University (United Kingdom)
Felix Mannhardt	Sintef (Norway)
Luis Marco	Nasjonalt Senter for e-helseforskning (Norway)
Niels Martin	Hasselt University (Belgium)
Steven Mertens	Ghent University (Belgium)
Jorge Munoz-Gama	Pontificia Universidad Católica de Chile (Chili)
Fernando Seoane	Karolinska Institutet (Sweden)
Jan Vanthienen	KU Leuven (Belgium)
Moe Wynn	Queensland University of Technology (Australia)

Healthcare practitioners

Name	Institution
Jochen Bergs	Hasselt University (Belgium)
Mieke Joosten-Melis	Radboud UMC (The Netherlands)
David Baltar Boilève	Hospital Universitario Lucus Augusti (Spain)
Stijn Schretlen	Medtronic
Bart Van Acker	Radboud UMC (The Netherlands)

Intended deliverable

Based on the discussions during the brainstorm seminar, a position paper on the seminar's topic is envisioned. This paper, which will be co-authored by all participants, will be submitted to a scientific journal.

Program overview

Thursday, June 27th 2019

	Session description	Chair/presenter
09.00		
09.15		
09.30	Arrival with coffee	-
09.45		
10.00	Opening	Niels Martin
10.15	Getting acquainted	-
10.30	[Brainstorm session 1] What are the needs, concerns and aspirations in the healthcare domain?	Niels Martin
10.45		
11.00		
11.15		
11.30		
11.45		
12.00		
12.15		
12.30	Lunch break	-
12.45		
13.00		
13.15	[Brainstorm session 2] How to embed process mining in the hospital structure/culture?	Carlos Fernandez-Llatas
13.30		
13.45		
14.00	[Brainstorm session 3] How to gather or create a sound event log as an input for process mining in healthcare?	Niels Martin
14.15		
14.30		
14.45	[Presentation 1] Congestion mining in healthcare	Avigdor Gal
15.00	Coffee break	-
15.15		
15.30	[Brainstorm session 4] How to show the effectiveness of process mining in healthcare?	Roberto Gatta
15.45		
16.00		
16.15	[Brainstorm session 5] How to deal with temporal changes in healthcare processes?	Owen Johnson
16.30		
16.45		
17.00		
17.15		
17.30		
17.45		
18.00	Guided city walk	-
18.15		
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18.45		
19.00	Dinner	-
19.15		
19.30		
19.45		
20.00		
...		

Friday, June 28th 2019

	Session description	Chair/presenter
09.00 09.15 09.30 09.45	[Brainstorm session 6] Which opportunities and challenges does Healthcare 4.0 in general and IoT in particular provide for process mining research?	Avigdor Gal
10.00 10.15 10.30	[Brainstorm session 7] How to enhance the understandability of process mining outcomes for healthcare practitioners?	Jorge Munoz-Gama
10.45 11.00	Coffee break	-
11.15 11.30 11.45	[Brainstorm session 8] How can process mining support benchmarking in healthcare?	Luis Marco
12.00	[Presentation 2] Diagnostic analytics in healthcare	Niels Martin
12.15 12.30 12.45	Lunch break	-
13.00 13.15 13.30	[Brainstorm session 9] How to take into account legal and privacy issues when conducting process mining research in healthcare?	Moe Wynn
13.45 14.00 14.15	Synthesis session	Niels Martin
14.30 14.45	Coffee break	-
15.00 15.15 15.30	Synthesis session (continued)	Niels Martin
15.45	Closing	Niels Martin
16.00 16.15 16.30 16.45 17.00		

Detailed program

General

The program consists of nine brainstorm sessions and two brief presentations:

Brainstorm session

A brainstorm session focuses on a particular topic related to process mining in healthcare. For each session, a chair and a responsible for the notes is assigned:

- The **chair** will moderate the discussion. Moreover, the chair will open the discussion by giving a short presentation on that particular topic. The presentation aims to set the stage for an interesting discussion. It can include the chair's point of view on the topic, and can add critical remarks with respect to the state of the art in literature. The idea is to limit the introductory presentations to 10 to 15 minutes in order to leave sufficient time for discussion.
- The responsible for the **notes** will be requested to keep track of the key points raised in the discussion. To this end, a shared document to which all seminar participants will have access will be created. The session chair is also included to add points, potentially after the session. The document with the notes, combined with the outcomes of the synthesis session on Friday, will be the key inputs for the position paper (the intended deliverable of this seminar).

Presentation

Besides the brainstorm sessions, two presentations of 15 minutes each are also included in the program. These presentations aim to introduce a particular research topic or idea. Even though they will not be followed by a discussion round, the presentations can offer further food for thought during the breaks.

Thursday, June 27th 2019

09.30 – 10.00: Arrival with coffee

10.00 – 10.15: Opening

Opening remarks by Niels Martin

10.15 – 10.30: Getting acquainted

Before starting the discussions, it is nice that we get to know each other a little. Consequently, each participant will receive one minute to introduce themselves and to mention their core healthcare-related research interests.

10.30 – 12.30: What are the needs, concerns and aspirations in the healthcare domain? [Brainstorm session 1]

Chair and introduction	**Niels Martin**
Notes	**Gema Ibáñez, Niels Martin**

This session will consist of a series of presentation from healthcare practitioners, followed by an interactive discussion.

During the presentations, healthcare practitioners will provide some perspectives and reflections from their experiences in practice. As a guide to build up their presentation, the following questions were provided to them upfront:

- What are process mining use cases that you experienced in daily practice? What is your critical assessment of these use cases?
- What are the real-life questions that process mining should help to solve in healthcare practice?
- How can the usability/understandability of process mining techniques in a healthcare context be improved?
- How does healthcare staff perceive process/data analysis projects: as an opportunity or as a threat?
- What are the key themes that process mining research should focus on from a healthcare perspective?

12.30 – 13.15: Lunch break

13.15 – 14.00: How to embed process mining in the hospital structure/culture? [Brainstorm session 2]

Chair and introduction	**Carlos Fernandez-Llatas**
Notes	**Fernando Seoane, Carlos Fernandez-Llatas**

Statements:

Name	*Statement with some background explanation*
Jorge Munoz-Gama	*The PM embedding must be done through the "process department" or the "analytics department" of the hospital, if they have.* *Main clinics in Chile has a "process department"*
Roberto Gatta	*"We need to give some empirical evidence of pros and cons of PM; being ready to define a feasibility study in terms of costs and benefits"* *embracing a new paradigm is not free: being able to document (a bit) expected costs and benefits could reduce barriers*
	"Sometimes (often?), barriers are human more than institutional" *We need to be inclusive, in the consortium, of people with a key role in some big hospital (administrative roles?), aiming to create a "pull factor"*
	"trojan horses"

	Can pharmaceutical, electromedical device vendors, EHR providers, ... be a way to pass through the door of the castle? Maybe providing tools and creating the habits to a PM point of view of data and management?
Niels Martin	*"Embedding process mining in the hospital culture requires that staff at different levels see the added-value of process mining"* *In order to embed process mining in the hospital culture, it is not sufficient that hospital management or medical doctors are convinced about its added-value. It is required that staff at different levels (nurses, administrative staff,...) see the benefits. This can also have side effects such as more accurate data recording.*
Carlos Fernandez-Llatas	*No one-fit-all solutions. Approach the solutions adapting the medical evidences to daily practice. Make the health professional part of the learning system. interactive models*
Moe Wynn	*How can we leverage the evidence-based culture within the hospital setting to demonstrate the benefits of process mining to various stakeholders and get their buy-in?*
Avigdor Gal	*"We need to provide incentives to various stakeholders to participate willingly and truthfully in data gathering processes"* *Humans provide data in a manner that is biased by their own goals. When filling forms, humans may over or under emphasize certain facts. When humans know their movements are being followed, they may change their patterns to fit their own goals. The use of psychology and game theory is essential in creating a method for efficient and effective data gathering.*
Steven Mertens	*"PM should be integrated in the IT-systems and in a way that is almost invisible to the users"* *PM should not be limited to isolated projects, but rather be an integrated and core part of the next-generation hospital information systems.*

14.00 – 14.45: How to gather or create a sound event log as an input for process mining in healthcare? [Brainstorm session 3]

Chair and introduction	**Niels Martin**
Notes	**Jorge Munoz-Gama, Niels Martin**

Statements:

Name	*Statement with some background explanation*
Jorge Munoz-Gama	*"Log creation must be top-down:"* *First, imagine/draw the model (with the specific activities) that would answer your research questions; second, define how each activity would be constructed from the data available*
Jorge Munoz-Gama	*"No field in the database should be considered directly as the "activity" of the log, but be constructed from the database fields."* *(Otherwise, we have lots of activities, and lots of arcs, and end up filtering by frequency, and losing lot of behavior)*

Roberto Gatta	*"for pilot investigations a data-driven identification of the possible goals can make sense"* *We also need to explore the "bottom up approach", from existing data to knowledge, in order to be able to give a quick answer to the question "which can be a cheap, fast and effective first pilot experience of PM, with existing data, in my institution?*
	"We need to overcome the limitation of the offline analysis, in building Event Logs" *we need to be able to provide tools and scenarios that allows Process Discovery and Conformance Checking in near-real-time, connecting clinical data sources (EHRs, HIS, PACS, ..) via the most common standards in medical informatics (e.g. ODBC, HL7, DICOM, etc..)*
Niels Martin	*"Solely using HIS, it is (almost) impossible to obtain an event log that enables process mining to reach its full potential"* *Based on several years of experience in working with hospitals, I realized that significant data quality issues are present in HIS-data. In literature, assessment techniques and improvement heuristics have been proposed. Even though these efforts are very valuable, we also might need to admit that it is (almost) impossible to obtain an event log that enables the full process mining potential from HIS-data. The typical goal is to obtain an event log that is adequate for the specific analysis that needs to be conducted. However, is this ambitious enough?*
Carlos Fernandez-Llatas	*Data Rodeos to approach success cases to real daily practice*
Moe Wynn	*We keep to keep track of the provenance of an event log; how/where it is generated; we need a replicable; semi-automated way of assessing the quality of an event log.*
Avigdor Gal	*"The ROAD to a sound event log is paved with good decisions"* *The use of low level events in hospitals (e.g., by using RTLS data), posts interesting challenges of translating low-level events to high level events that correspond to activities.*
Steven Mertens	*"A collaboration with the HIS- and other EHR-manufacturers is needed so that the data that gets captured can optimized for the creation of rich event logs"* *Often, it's the hospitals and its doctors that are involved in the projects, but they have little control over their HIS.*

14.45 – 15.00: Congestion mining in healthcare [Presentation 1]

Presentation on congestion mining by Avigdor Gal

15.00 – 15.30: Coffee break

15.30 – 16.15: How to show the effectiveness of process mining in healthcare? [Brainstorm session 4]

Chair and introduction	**Roberto Gatta**
Notes	**Steven Mertens, Roberto Gatta**

Statements:

Name	*Statement with some background explanation*
Niels Martin	*"Showing the effectiveness of process mining in healthcare requires linking the analyses to clinical outcomes"* *Process mining researchers agree that process mining can generate useful insights into healthcare processes. However, in order to convince clinicians about the effectiveness of these techniques, a link to clinical outcomes is required. This would require study settings in which an analysis of clinical outcome parameters is conducted on historical data. Afterwards, changes to the process are implemented based on the insights from a process mining analysis. As a final step, the clinical outcomes of the redesigned process are measured. The comparison with the pre- and post-intervention outcomes makes it possible to show how process mining leads to actionable insights in the process which are beneficial for clinical outcomes. In current literature, such study designs have not been considered, probably due to its complexity.*
Jorge Munoz-Gama	*"Animations are sexy"* *(Animating the behavior is only interesting in really specific scenarios, but it sells PM really well to final stakeholders, because they imagine an on-time analysis)*
Roberto Gatta	*"There is a cultural gap and we need a bridge: new eyes to better identify goals, new languages to create expectations and share results"* *The Consortium should include a team of physicians, able to create a network and propose (a) application domains, (b) effective initiatives, (c) link the many clinical association (e.g. ESTRO, European Society for Radiotherapy & Oncology, EFIM, European Federation of Internal Medicine, etc..).*
	Real Use cases
Moe Wynn	*We need clinical stakeholders, we need process improvement scenarios tied to process mining outcomes. I agree with Jorge, "Animations and Visualisations!"*
Avigdor Gal	*"It typically starts with low-hanging fruits"* *Visual analytics is a good place to start*
Steven Mertens	*"Instead of focussing on clinical outcomes, which are hard to quantify, we should on the management side (e.g., saving time, reducing work pressure on doctors, better utilization of available resources...)"*

16.15 – 17.00: How to deal with temporal changes in healthcare processes? [Brainstorm session 5]

Chair and introduction	**Owen Johnson**
Notes	**Luis Marco, Owen Johnson**

Statements:

Name	*Statement with some background explanation*
Owen Johnson	*Nothing stands still in health so temporal drift or concept drift in healthcare processes and the data we mine demands special attention. We can consider temporal drift from a number of perspectives. 1) How to check for conformance of processes over time? 2) How to discover internal and external process change points and attribute cause and effect? Plus, 3) Worrying thought: how valid is our process mining if we don't look for and consider temporal drift? And, 4) Exciting thought: how might we create learning health systems where process enhancements are continually evaluated and improved in real-time?* *A starting point for discussion might be to accept the bleak inevitability of our situation. This is not as bad as it sounds, we can consider electronic healthcare record (EHR) data as the product (and the producer) of the intricate, complex and ever changing socio-technical environments within healthcare organisations (systems theory, Leavitt's diamond model etc). Conformance checking (and simple stats) on time boxed segments of the event log can help understand the nature and extent of change and detect incremental drift (e.g. increasing demand) and radical change points (e.g. a new EPR system). There is a likely trade-off between time-box size, process length and data volumes and we need to develop notions of "normal variance" (e.g. process change linked to day of week or hour of day). For the future, there are opportunities to develop new tools that can learn from, adapt to, implement and continuously evaluate process improvements. This might take process mining into the realms of AI and radically new models of data-driven healthcare that would be interesting to explore.*
Niels Martin	*"Several types of concept drift need to be distinguished."* *Everybody agrees that processes change over time. Process mining techniques need to take this into account: treating an event log stretching over a long time period as representing the execution of the same process can lead to misleading results. However, several types of concept drift need to be distinguished. While changes in medical guidelines/pathways can lead to abrupt changes in the process, other changes can be more gradual (e.g. a change in particular work practices). Do these different types of concept drift be handled differently in a healthcare setting? How can we determine whether different types of concept drift are desirable? An interesting starting point on this matter is the following paper: Maaradji, A., Dumas, M., La Rosa, M., & Ostovar, A. (2017). Detecting sudden and gradual drifts in business processes from execution traces. IEEE Transactions on Knowledge and Data Engineering, 29(10), 2140-2154.*
Carlos Fernandez-Llatas	*Interactive Models are resilient to concept drift because are continuously adapting the process to the real patients.* *C. Fernández-Llatas, T. Meneu, V. Traver, and J.-M. Benedi, Applying Evidence-Based Medicine in Telehealth: An Interactive Pattern Recognition Approximation, International Journal of Environmental Research and Public Health, vol. 10, no. 11, pp. 5671–5682, 2013.*
Moe Wynn	*I am not sure that this issue is more prevalent in healthcare or not. I found the issue with the concept drift in many logs; not just in the healthcare logs.*

Avigdor Gal	*"I became insane, with long intervals of horrible sanity" (Edgar Allan Poe)* *Temporal networks were introduced in BPM'17 as an interval-based modeling tool*

18.00 – 19.00: Guided city walk

During a guided city walk, we will have the opportunity to discover some of the history of the city of Hasselt. The guide will meet us at the hotel (Holiday Inn Express Hotel, Thonissenlaan 37, Hasselt) and the walk will end at the restaurant (Restaurant 't Kookpunt, Hemelrijk 13, Hasselt).

19.00 - …: Dinner

In the evening, we can enjoy dinner at restaurant 't Kookpunt in the city center of Hasselt (Hemelrijk 13, Hasselt)

Friday, June 28th 2019

09.00 – 10.00: Which opportunities and challenges does Healthcare 4.0 in general and IoT in particular provide for process mining research? [Brainstorm session 6]

Chair and introduction	**Avigdor Gal**
Notes	**Niels Martin, Avigdor Gal**

Statements:

Name	*Statement with some background explanation*
Jorge Munoz-Gama	*"We must think inside the hospital but also outside of it"* *(That includes telemedicine, monitored houses, …)*
Roberto Gatta	*"Can General Practitioners and chronic diseases be a winning couple of keywords?"* *GPs have a general overview, not limited from the hospital walls. Chronic diseases are the most promising domain to assist patients in their domestic management with medical devices to collect data.*
Niels Martin	*"Data integration research is required as IoT will reshape process mining in the healthcare sector"* *Currently, process mining in healthcare typically takes data from a hospital information system as a starting point. However, from a process mining perspective, hospital information systems data suffers from important limitations. IoT platforms such as a real-time location system also captures useful process execution information. As IoT will become increasingly present, also in healthcare, it is important that process mining can handle data originating from a plethora of different information sources, each having their strengths and limitations. To this end, there is a need for research on data integration: a research topic I am very interested in myself.*
Moe Wynn	*"Extracting knowledge from existing healthcare systems relies on automated correlation"* *Currently, there is a huge delay in extracting healthcare event logs due to the long lead time for correlating data from multiple systems. We need better ways to correlate and integrate healthcare datasets.*

10.00 – 10.45: How to enhance the understandability of process mining outcomes for healthcare practitioners? [Brainstorm session 7]

Chair and introduction	**Jorge Munoz-Gama**
Notes	**Moe Wynn, Jorge Munoz-Gama**

Statements:

Name	*Statement with some background explanation*
Jorge Munoz-Gama	*"We need a specific Process Modeling Notation suitable for (specific cases) in healthcare"* *Petri net (and similar) won't work for understandability of non-experts. But neither BPMN (and similar) since most processes are quite unstructured. Finally Process Maps (Celonis/Disco/…) are the closest in terms of understandability but they are not well tuned for this specific scenario: 1) it shoulds arcs and arcs, when maybe some kind of "pattern" representation should improve the understandability 2) with so many activities and arcs we end up filtering by frequency, when maybe a zoom-in-zoom-out modeling notation could help on that. I propose a Process Map variant (nodes and arcs), with some specific "elements" for a specific common healthcare scenario (of course, it's not the same a "visit on the hospital", than a "IoT position-monitoring", or a "long period appointments engagement"*
	"We should validate the Process Modeling Notations for Healthcare in a multi-country study with real doctors and medical agents" *That could be a nice paper :)*
Roberto Gatta	*"Clinicians: a population from many ages, many countries, many disciplines => many subcultures"* *A first extended survey, centered on linguistic issues and general background information, designed from a multidisciplinary team (e.g.: physicians, cognitive scientist, computer scientists) could help us in getting the picture of the population we want to work on. Can this help us to identify the subjects, the "use case", of our further proposals?*
Niels Martin	*"There is a risk that enhancing understandability boils down to (over-)simplification."* *The concepts of understandability and simplicity are often connected. In a naive approach, a model's understandability can be enhanced by simplifying it. However, especially in a healthcare setting, this will quickly lead to oversimplification. Hence, when enhancing the understandability of process mining results, the risk for oversimplification should always be taken into account.*
Carlos Fernandez-Llatas	*No one fit all solutions.* *Each professional need different views. Different views - one process*
Steven Mertens	*"Limit the first time exposure of users to small bits of information from the PM results, directly related to the operational goal that they are trying to achieve"* *Big and complex models scare of doctors and other personnel. However, displaying (by any means) a small piece of the model that applies to the patient that sits in front of them, will make it much more tangible to the doctors.*

Avigdor Gal	*Folding is a technique that was presented as a method for simplifying discovered models. A challenge is folding into a meaningful set of activities*

10.45 – 11.15: Coffee break

11.15 – 12.00: How can process mining support benchmarking in healthcare? [Brainstorm session 8]

Chair and introduction	**Luis Marco**
Notes	**Carlos Fernandez-Llatas, Luis Marco**

Statements:

Name	*Statement with some background explanation*
Roberto Gatta	*"Conformance Checking and Clinical Guidelines: an easy way for having readable benchmarking"* *The growing role of Clinical Guidelines (CG), aiming the quality of care and/or legal implications, can intuitively fits with CC aims and tools. Moreover, CG represent a first, easy to understand, application domain for almost all physicians.* *However, CC from the original perspective of PM is not yet ready to cope with this task but PM4HC should elicit this need and include the problem of CG into the perimeter of the discipline. From this perspective, for example, Process Enhancement can be read as a data-driven improvement of a CG workflow (an evidence-driven improvement able to consider a specific Institution).*
	"Resource allocation via a 'what if' based approach: when Process Mining looks to Scheduling and Planning" *For administrative and organizational purposes, the availability of simulators (e.g. mined with Process Discovery) can help in building simulators to measure the expectation for the future (in terms of resource allocation) and, if hypothesis can be supported, to test some "what if" scenarios.*
Niels Martin	*"Using process mining for hospital benchmarking requires the definition of pathology-based process key performance indicators"* *Hospital benchmarking typically involves comparing hospitals on particular standardized clinical outcomes. A similar standardization procedure will be required when we want to use process mining for hospital benchmarking. This involves defining process key performance indicators in close contact with clinicians. In this respect, a pathology-based approach is recommended.*
	"Process mining extends hospital benchmarking to cross-hospital learning" *Currently, hospital benchmarking is often based on an initiative of the government and typically relates to a set of clinical outcomes. When process mining is used for hospital benchmarking, cross-hospital learning becomes possible. By gaining insights in the differences between processes (linked to clinical outcomes), hospitals can learn from one another. However, in an increasingly competitive setting, it is questionable whether hospitals are willing to enter in such cross-hospital learning programs. In that respect, setting up learning clusters of hospitals which are geographically distant poses an opportunity.*

12.00 – 12.15: Diagnostic analytics in healthcare [Presentation 2]

Presentation on diagnostic analytics by Niels Martin

12.15 – 13.00: Lunch break

13.00 – 13.45: How to take into account legal and privacy issues when conducting process mining research in healthcare? [Brainstorm session 9]

Chair and introduction	**Moe Wynn**
Notes	**Roberto Gatta, Moe Wynn**

Statements:

Name	*Statement with some background explanation*
Roberto Gatta	*"From mono-centric to multi-centric Process Mining investigations"* *In case of success, PM4HC will probably cope with the challenge of Multi-centric studies, to mine processes from data collected with the contribution of many centers. Similarly, measures of the adherence with clinical guidelines, protocols, consensus, and procedures will probably be investigation endpoints. This means that Patient's Privacy and data ownership issues will be pivotal. Can be the Distributed Learning approach can be one of the possible tools to ensure Patient's privacy and Data Ownership?*
Niels Martin	*"Data anonymization is not straightforward"* *When a dataset is provided by a hospital for process mining purposes containing personal data, GDPR regulations hold. Anonymized data is not under the application domain of GDPR and requires that an individual cannot be directly/indirectly identified from a dataset. A combination of actions can be taken to anonymize a dataset: changing the patient identifier with a random number, remove information such as name/address/gender/…, apply a random time shift (consistent for all events),... However, it is difficult to determine which combination of operations is required to obtain an anonymized dataset. Are their rules of thumb to determine when a dataset can be considered as anonymous?*
Avigdor Gal	*"Medical institutes need assistance in complying with privacy regulations. Blockchain and Database technology hold the answer"* *GDPR, as an example of privacy regulation, puts extra pressure on medical institutes and typically serves as a stumbling blocks to embedding data technologies. We need to create (or use existing) technological tools to help medical institutes deal with data given privacy regulations.*
Moe Wynn	*"Balancing Privacy and Utility"* *Personal data about patients and employees can be recorded as part of the healthcare data sets and such data is subject to privacy regulations. Typically, such personal data is de-identified during the pre-processing step by anonymising the names of people using codes. Other data transformation methods go further to generate de-identified data using sampling, data swapping, time shifting, and adding noise from a known distribution, etc. Such transformation can significantly reduce the utility of (sanitised) healthcare data for process mining. Most process mining techniques are 'privacy-agnostic', that is, they consider such (sanitised) data as the whole truth, thus reducing the accuracy of analysis results.*

13.45 – 14.30: Synthesis session

The goal of the synthesis session is to bring together the key points from the several brainstorm sessions. This will provide input for the position paper, which is the intended deliverable of the seminar. Moreover, this can be a moment to reflect on potential efforts by the Process-oriented Data Science for Healthcare Alliance.

14.30 – 14.45: Coffee break

14.45 – 15.45: Synthesis session (continued)

The goal of the synthesis session is to bring together the key points from the several brainstorm sessions. This will provide input for the position paper, which is the intended deliverable of the seminar. Moreover, this can be a moment to reflect on potential efforts by the Process-oriented Data Science for Healthcare Alliance.

15.45 – 16.00: Closing

Closing remarks by Niels Martin

Practical information

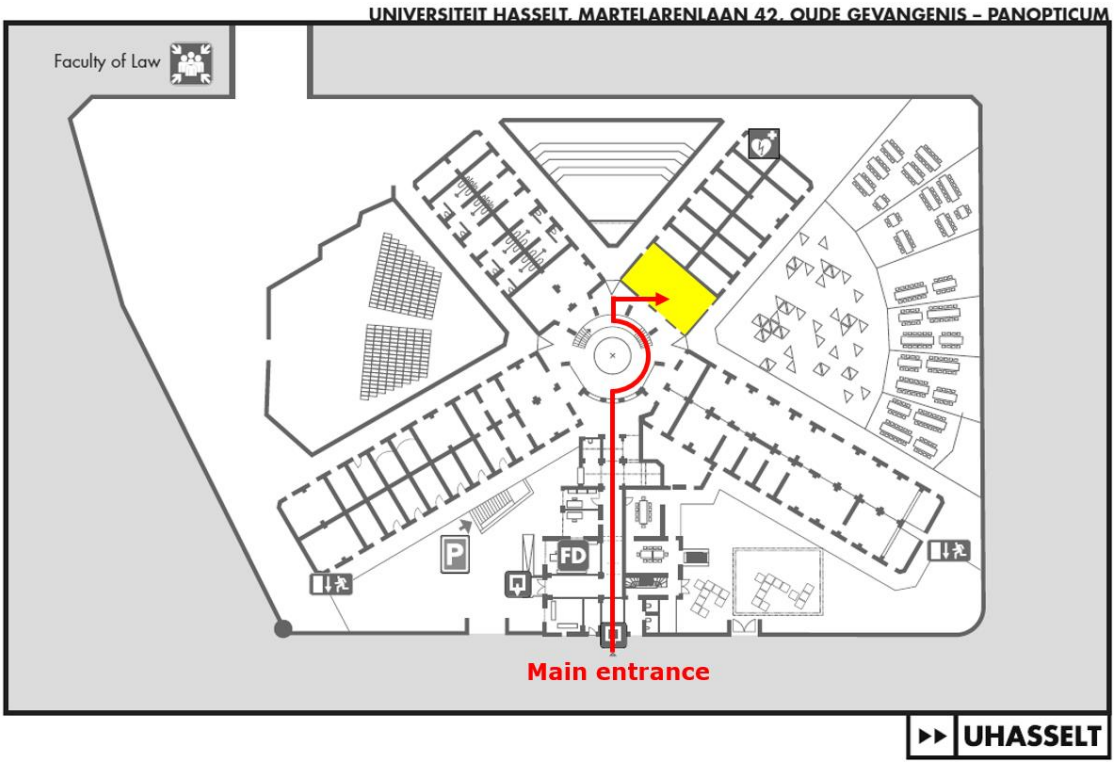
Seminar location

Address seminar location

Hasselt University – City campus
Martelarenlaan 42, 3500 Hasselt, Belgium

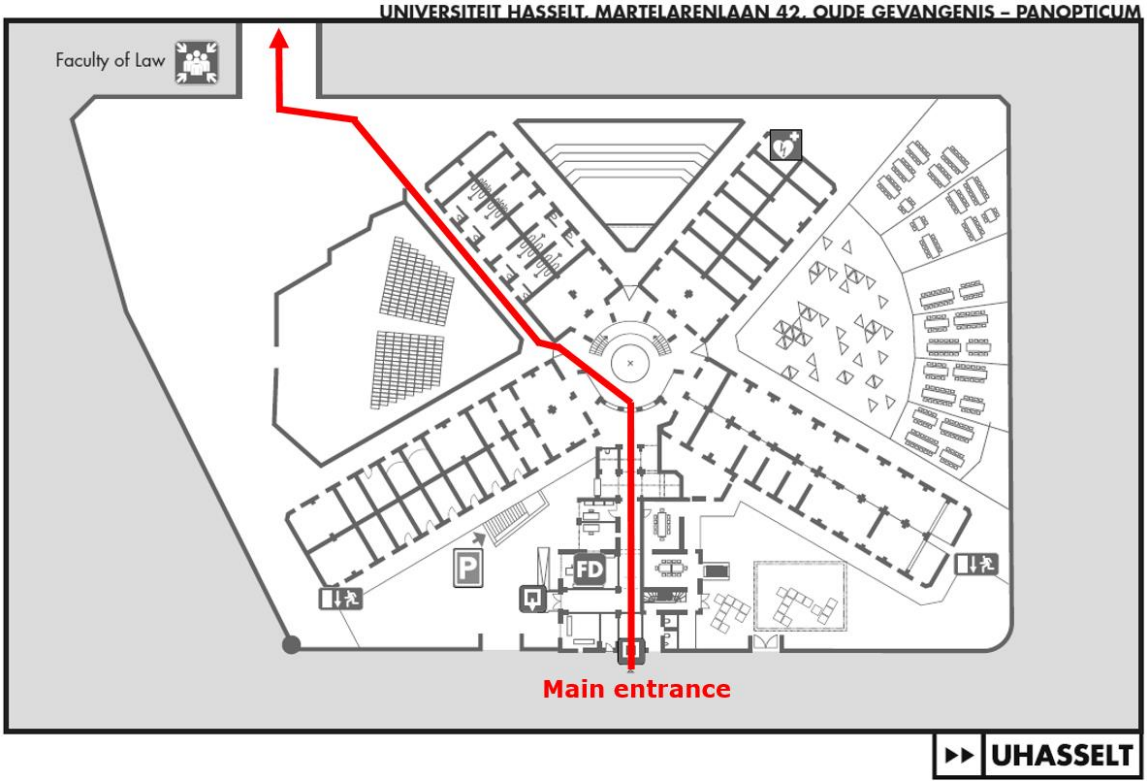
Room first seminar day (Thursday, June 27th):

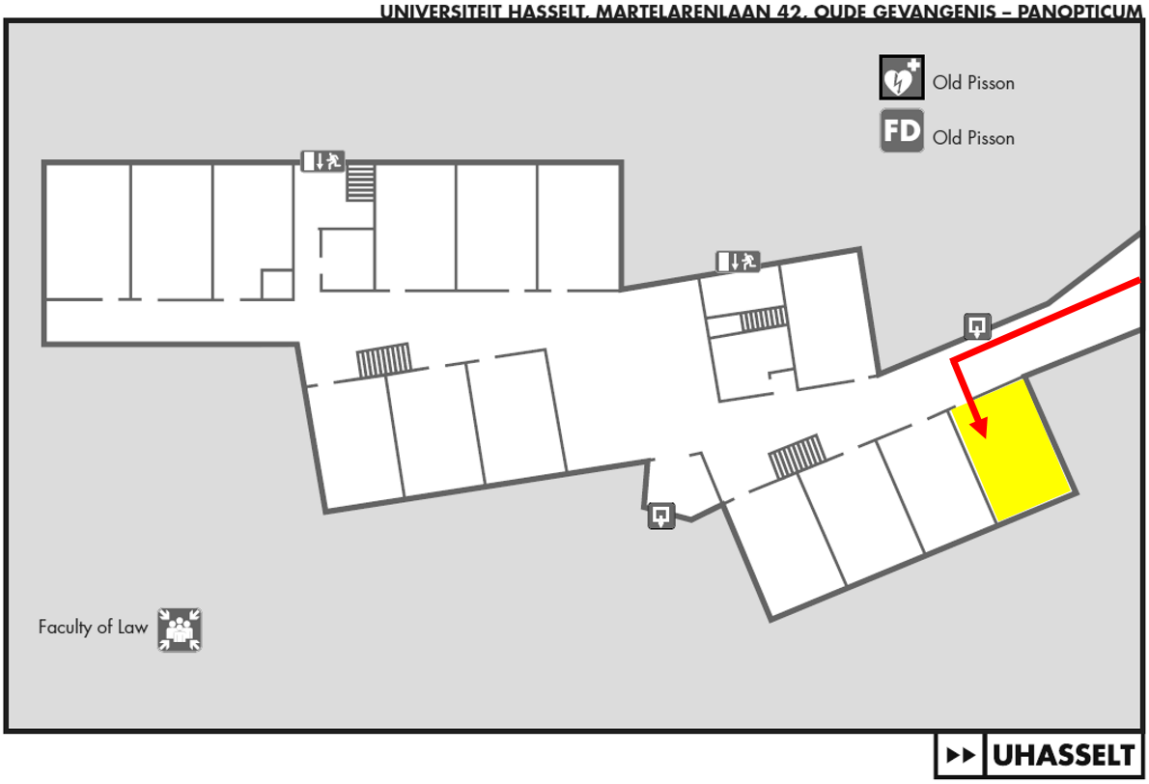
Hasselt University – City campus
Old Prison – Yellow room (this is the room with the yellow doors you see after using the stairs to reach the first floor)



Room second seminar day (Friday, June 28th):

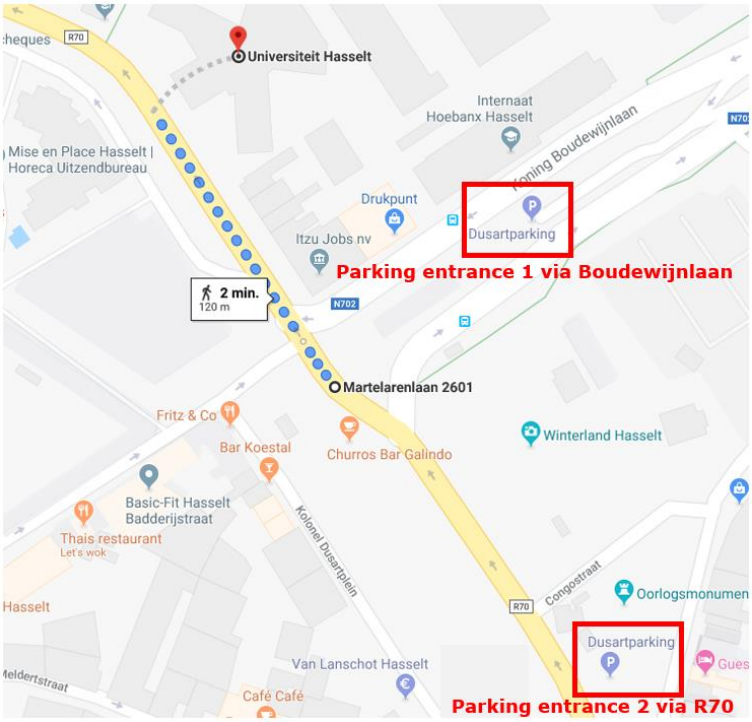
Hasselt University – City campus
Building Faculty of Law – Room FR0.01 (leave the 'Old Prison' building following the marked route on the first map to enter the Faculty of Law building on the second map)





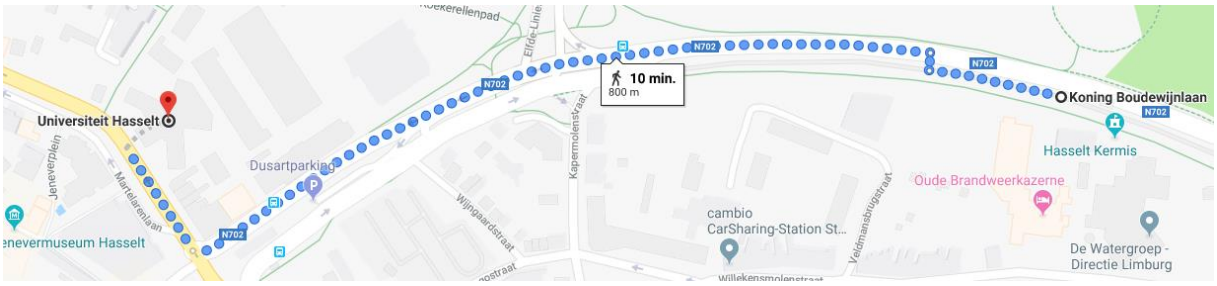
Parking lots on a walking distance from the seminar location

Q-park Dusart (underground parking)
Address: Koning Boudewijnlaan, 3500 Hasselt, Belgium
Rates: €2.00 per 50 minutes, €16.00 maximum daily rate
Walking time to campus: +/- 2 minutes



Parking Kolonel Dusartplein
Address: Wijngaardstraat, 3500 Hasselt, Belgium
Rates: €1 per 5 hours
Walking time to campus: +/- 5 minutes

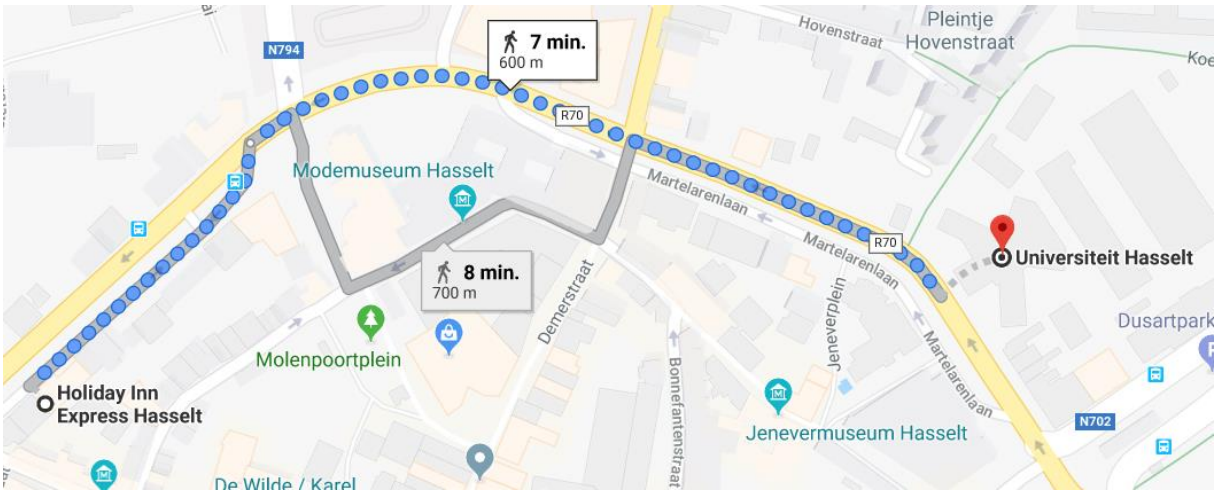
Parking Koning Boudewijnlaan
Address: Koning Boudewijnlaan, 3500 Hasselt, Belgium
Rates: free
Walking time to campus: +/- 10 minutes



Hotel

Holiday Inn Express Hotel
Address: Thonissenlaan 37, 3500 Hasselt, Belgium
Telephone: +32 11 37 93 00
E-mail: info@hiexhasselt.com

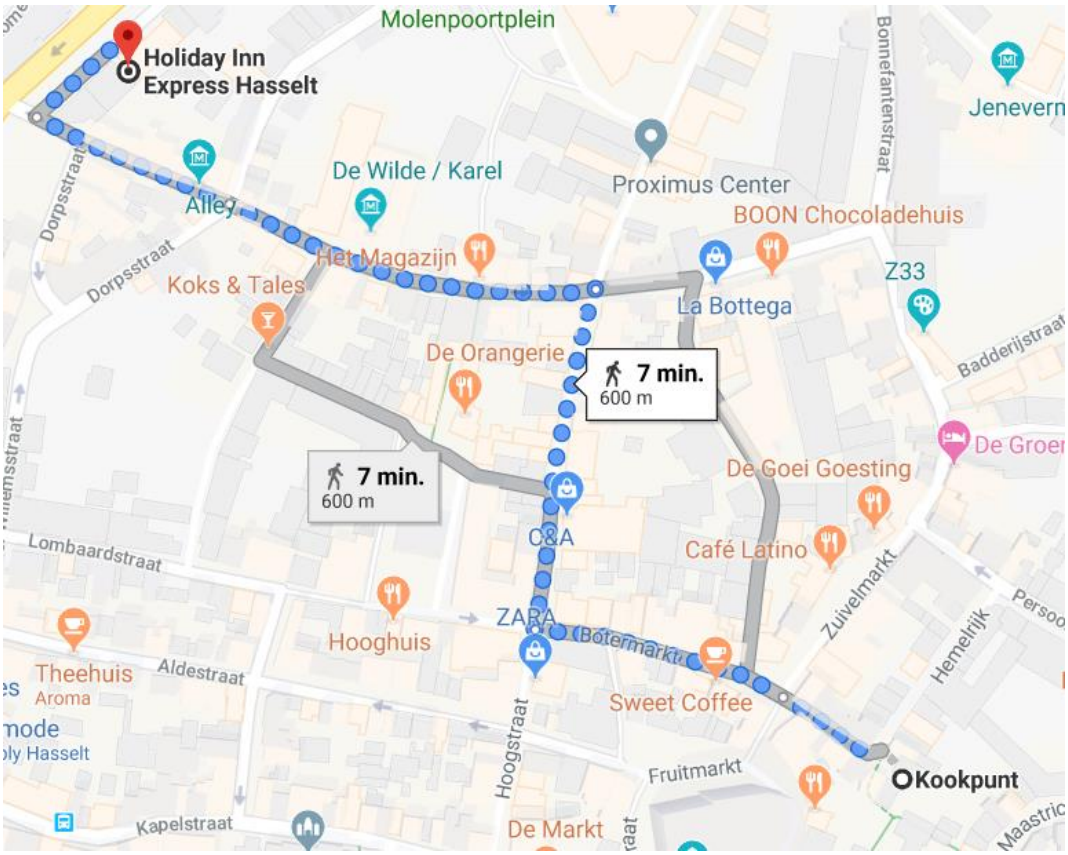
Walking route from the hotel to the seminar location (600m, walking time of about 7 minutes):



Dinner

Restaurant 't Kookpunt
Address: Hemelrijk 13, 3500 Hasselt, Belgium

Walking route from the restaurant to the hotel (600m, walking time of about 7 minutes):



Hasselt train station

For those having a return flight from Brussels Airport: there is a direct train connection from Hasselt station to Brussels Airport. The train journey takes about one hour. Train tickets can be bought online in advance (https://www.belgiantrain.be/en/search) or in the station.

Walking route from the seminar location to the station (1.3km, walking time of about 16 minutes):