Project Description

02268 – Process-oriented and Event-driven Software Systems

February 13, 2023

General instructions

The project has to be conducted in teams of 6 persons. The project consists of identifying a scenario relevant in terms of processes automation and event generation/consumption and implementing it. The process implementation should use a Process Aware Information System (PAIS) (e.g., Camunda). The project should make use of a system for Complex Event Processing (CEP) (e.g., Siddhi, Apache Flink). The project also needs to include interaction between PAIS and CEP **in both directions** (i.e., from the CEP platform to the PAIS and from the PAIS to the CEP platform). Each group can choose their own scenario based on their experience, interests, working experience or, general preference but there is the possibility to use one of the themes/scenarios suggested in this document. Each group has to conduct a study to identify the processes and the event sources and implement their application.

In order to be successful, the project has to involve at least (i.e., minimum requirements, amount of work should be commensurate the expectations of the group):

- 6 business processes (at least one must be a BPMN model[1] where most of the elements discussed during the lecture have to be properly used)
- Implementation of the processes in at least 1 PAIS (*at least* means that 1 is enough)
- 2 external event sources
- Some processing of the events with proper CEP agents (e.g., Siddhi or Apache Flink)
- **Bi-directional communication** between the PAIS and the CEP.

The deliverable should include a report where each group has to describe what they have done in a critical way (i.e., motivate their decision) as well as provide a link to a URL with an exhaustive screencast of all implementation details; the code of the application itself; the slides of the presentation that will be given. Further instruction below.

[1] You may want to have some Petri net too or any other .

Suggested theme 1: Reduce raw-material waste

The United Nations Environment Programme defines[2] "food waste" as:

> *Food waste refers to food that completes the food supply chain up to a final product, of good quality and fit for consumption, but still doesn't get consumed because it is discarded, whether or not after it is left to spoil or expire. Food waste typically (but not exclusively) takes place at retail and consumption stages in the food supply chain.*

This topic is of extreme importance and represents one of the 17 Sustainable Development Goals[3]. Goal of the project is to reduce the food waste by enabling the proper tracking of the food and having specific events triggering processes with the aim of reducing such waste. Alternatively, the goal is to modify existing processes so that events can be used towards a more responsible development. Example of possible application scenarios are bakeries, ice cream shops, restaurants, fast foods, etc. who might want to reduce the waste of food, for example due to upcoming expiration of some raw material, by discounting specific products or rolling out promotions, therefore triggering full usage of the raw material. Other possibilities would be to construct new "man in the middle" services to foster the same goal. Examples of such services are OLIO, Too Good To Go, Winnow, Smart Foodstuff.

Possible event sources capable of handling these cases are:

- Cash registers events (to keep track of what is being sell, what is in high demand at the moment, etc)
- New orders being generated from an e-commerce platform
- Events in the neighborhood of a physical shop (e.g., a football match that will attract many customers with specific needs)
- Weather conditions (e.g., very hot so people will be looking for something to cool, or very cold, so people will seek warming up).

Possible processes involved:

- The purchasing of new food to refill the stock
- Generating new offers for specific user profiles and specific products
- Support philanthropic initiatives, like helping food banks.

The very same principles can actually be applied to any setting where raw materials are transformed into final products or are just sold. For example, clothes shops, flower shops, travel agencies, butchers, greengrocers, pharmacies. Similar situations could also be in place for different needs, for example, to repurposing factories and facilities to cope with the pandemic[4].

[2] See https://www.stopfoodlosswaste.org/issue.
[3] See https://sdgs.un.org/goals/goal12.
[4] See https://www.unido.org/news/covid-19-critical-supplies-manufacturing-repurposing-challenge.

Suggested theme 2: Improved public transportation system

The public transportation system (for example busses and trains) is a very structured and well-orchestrated system where a lot of events need to happen at precise steps, to have it working smoothly. In this context, different notions of processes are possible.

For example, one could imagine a bus route as a sequential process, where each activity is a bus stop that should happen. The progress of such a process is typically automatically handled (i.e., when a bus reaches a stop a certain event is triggered and the process is moved forward) and many other require synchronization (for example, when busses approaches "connected bus stops" and need to wait for other busses to arrive before continuing).

Aside from normal operations, other type of processes could also be investigated. For example, after a certain amount of km/operation hours, maintenance should be scheduled. Alternatively, if busses are getting delayed too much (i.e., bottlenecks), new busses might be dispatched.

In Denmark, DOT[5] serves as a connection between different transportation companies and such interconnection allows the gathering of data which is then consumed, for example by Rejseplanen in their live visualization of all busses, trains (tog and S-tog), and metro[6]. The company also offers access to a set of REST APIs that can be consumed to know live information on trains[7].

[5] See https://dinoffentligetransport.dk/en/about-dot/.
[6] See https://www.rejseplanen.dk/bin/help.exe/mn?L=vs_dot.vs_livemap&tpl=fullscreenmap.
[7] See https://help.rejseplanen.dk/hc/en-us/articles/214174465-Rejseplanen-s-API and also a BSc project on the subject https://findit.dtu.dk/en/catalog/6083fcacd9001d01701fe6b7.

Suggested theme 3: Type 1 Diabetes Management

Type 1 Diabetes (T1D) is an autoimmune disease that causes pancreas to not produce insulin (or very little of it). Insulin, in turn, is a hormone which allows the sugar to leave the blood and enter the cells (where it is used for energy). A T1D patient that does not receive insulin, will have their sugar building up in the bloodstream and this can cause many complications. The amount of sugar in the blood is called glycaemia[8]. Currently, the only feasible treatment for T1D is to administer insulin externally (via Multiple Daily Injections – MDI, or via an insulin pump). To effectively do that, insulin should be provided before eating carbohydrates or when the glycaemia is above certain thresholds. The amount of insulin depends on the amount of food that will be eaten, personal characteristics (e.g., insulin resistance), and the current glycaemia. To verify the blood sugar level, it is possible to prick the finger and examine a drop of blood with a glucose meter[9] or by wearing a Continuous Glucose Monitor (CGM)[10].

The goal of the topic is to help patients in managing their T1D. Specifically, the procedures patients need to follow can be encoded as processes, while sources of data include the CGM, carbohydrates intake, physical activity, etc. The project could then monitor the continuous readings of glucose as well as the information regarding the food being eaten and physical activity and trigger proper steps in the process specification. For example, if the glucose level indicated by the CGM goes to up, a more accurate measurement is needed and proper countermeasures should be triggered (for example, an insulin injection); if food is about to be eaten, based on the current reading of the CGM and the amount of carbohydrates, then a certain amount of insulin should be administered. The results concerning the actions to execute might be reported as a notification on an app, a message, a screen blinking, etc.

Though there is **no** specific requirement on the clinical robustness of the procedures envisioned, it is expected that students taking this theme document themselves on the topic and hence are capable of devising realistic procedures. Possible sources of information are:

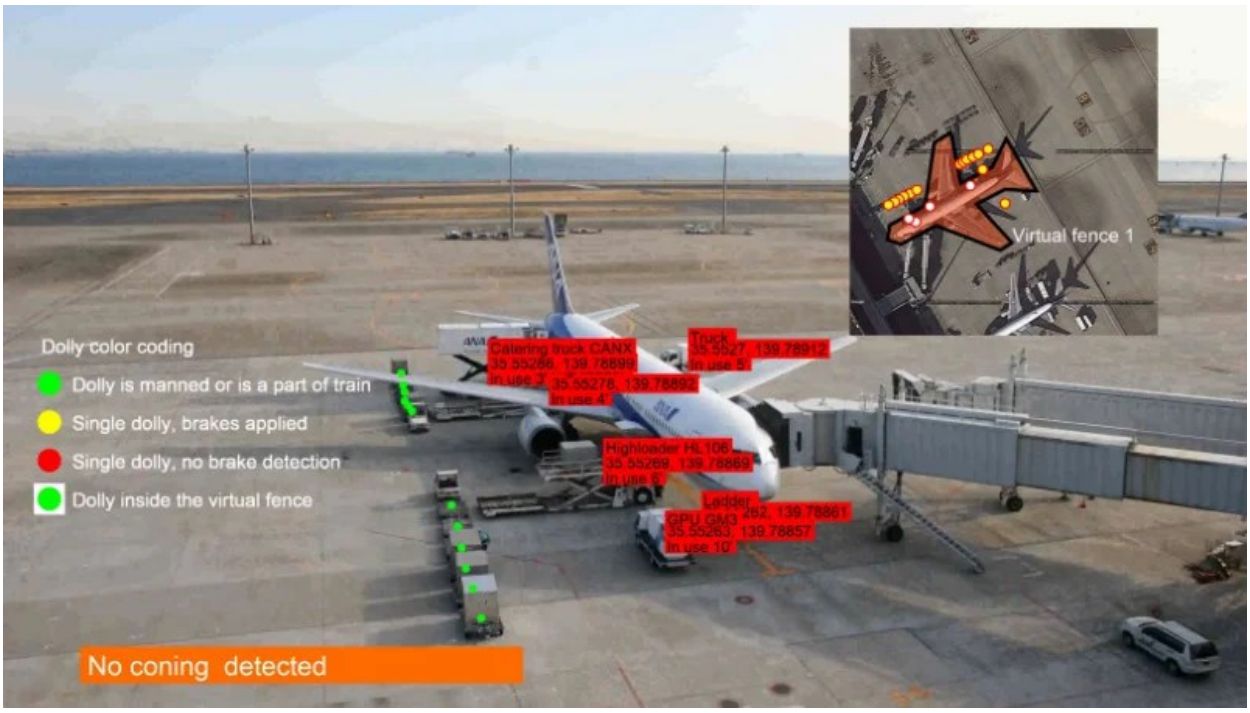
- https://www.ncbi.nlm.nih.gov/books/NBK279114/
- https://www.diabetesaustralia.com.au/living-with-diabetes/managing-your-diabetes/managing-type-1/
- https://diabetes.dk/diabetes-1/ny-med-diabetes-1 (in Danish)

While this data is highly personal and it is not possible to have access to it, a recent bachelor project[11] aimed at constructing a real time simulator for the purposes of this course[12]. Other datasets and simulation tools are discussed on the report mentioned in the bachelor report above mentioned.

[8] See https://en.wikipedia.org/wiki/Blood_sugar_level.
[9] See https://en.wikipedia.org/wiki/Glucose_meter.
[10] See https://en.wikipedia.org/wiki/Continuous_glucose_monitor.
[11] See https://findit.dtu.dk/en/catalog/63e0b6f3b1ad3f1285f5cc63.
[12] Source code available at https://github.com/annaskyjensen/T1DS and https://github.com/s194816/T1DSUseExample.

Suggested theme 4: Process tracking from video stream

Many real-world processes are "observed" via cameras. For example, consider the turnaround process at an airport[13]. Improving the digitalization of these processes could result in tremendous cost saving for airports and airlines and, as a result, for passenger's tickets. Initiatives to achieve part of such digitalization are in place[14].



In a recent Master project[15], two students worked on consuming data from cameras to understand how the turnaround process progresses. Integrating data from multiple sources (such as video + ADB-S[16]) could help improving the quality of the digitalization and hence the connection with the expected turnaround process.

Other domains might also be explored. For example, at DTU there is an initiative called DTU Smart Library[17] which aims at exposing data from sensors already deployed in the library.

[13] See https://findit.dtu.dk/en/catalog/5a1dfd1c5010df2563769897.
[14] See https://assaia.com/turnaround-control.
[15] See https://findit.dtu.dk/en/catalog/6216242583fe41235e4fb8af.
[16] See https://en.wikipedia.org/wiki/Automatic_Dependent_Surveillance%E2%80%93Broadcast.
[17] See https://www.bibliotek.dtu.dk/en/visit-the-library/dtu-smart-library.

Suggested theme 5: Predictive maintenance

Predictive maintenance is defined as

> *A condition-driven preventive maintenance program. Instead of relying on industrial or in-plant average-life statistics (i.e., mean-time-to-failure) to schedule maintenance activities, predictive maintenance uses direct monitoring of the mechanical condition, system efficiency, and other indicators to determine the actual mean-time-to-failure or loss of efficiency for each machine-train and system in the plant.* [18]

In case you are working or have knowledge of a specific facility or equipment, it might be possible to develop a predictive maintenance strategy by exploiting data being generated by sensors and analyzed using CEP. Such knowledge would then trigger specific maintenance processes with the ultimate goal of preserving the production capacity.

[18] From Section 1.1.3 of "An Introduction to Predictive Maintenance", https://findit.dtu.dk/en/catalog/2305333571.

Key dates

Project announcement:	2023-02-14
Group and topic decision:	2023-02-28 (on DTU Learn, there is **not auto-enrollment**)
Intermediate presentation:	2023-03-28
Submission of all material:	2023-04-30 23:59
Final presentation:	2023-05-02 morning (exact timing and scheduling will be provided once groups are known)

What to submit

Before the deadline, **each group must submit a `.zip` file** containing three elements. Please, **be precise with the naming of each element**:

1. A report in a file called **`report.pdf`** (the report has to be in PDF) which should be structured according to the document `demo-report.pdf` (attached to this project specification):
   - Has to be maximum 8 pages long (spare the space: do not use one page just for the title, another for the table of contents, etc.)
   - Has to provide a complete description of the context, the processes being used, why the group chose to implement them. In addition, a complete description of the events and corresponding processing must be provided in detail
   - Has to contain a link to a screencast (max 3 minutes) where **all** implemented functionalities have to be shown and commented.
2. The complete source code in a file called **`source.zip`**, including:
   - Process definitions (as `.bpmn` file as well as `.pdf`)
   - CEP agents source codes
   - Implementations of services (e.g., in Java), if any
   - PAIS customizations, if any.
3. The final presentation in a file called **`presentation.pdf`** (the presentation has to be exported in PDF).

Checklist of topics covered

In order to make sure that your project achieves the learning objectives, you can use this checklist and verify that all corresponding elements are discussed in your report and presentations:

	✓
I have applied methods and techniques for analyzing business processes to identify improvement opportunities	
I have identified and created business process models using a business process modeling notation like BPMN or Petri nets	
I have improved early designs of business processes based on different redesign heuristics	
I have implemented a business process directly from a business process model using a PAIS	
I have discussed different approaches to integrated business process management and sensor events	
I have integrated event processing with a business process management system	
I have established communications from event sources to a business process management system	
I have established communications from a business process management system to IoT devices	
I have worked in team to solve a problem	

Checklist of submission material

In order to make sure that your project respects the rules of the submission, you can use the following checklist:

	✓
The submission comprises just one zip file	
The zip file contains one document called report.pdf which is ≤ 10 pages long	
The zip file contains a file called source.zip with all process files and all other sources	
The zip file contains one document called presentation.pdf	

The intermediate presentation

On 2023-03-28, there will be a first group presentation, where each group has a certain amount of minutes (around 10/15 minutes, exact time will follow once I know how many groups intend to present) to present the status of their project (+ 3 minutes for questions/answers). The goals of this presentation are:

- Practice with presentation and dealing with time constraints as well as questions (that is why it is important to carefully prepare this presentation)
- Receive feedback from instructors as well as from other students (that is why it is important to carefully prepare this presentation)
- Get inspiration from other groups' work (that is why it is important to attend and be involved in the discussions).

This presentation **is not** part of the grading (it is up to you get the most out of this opportunity).

The final presentation

Each group will need to present their project in a 10/15 minutes long presentation (exact duration will be announced later). During the presentation, it is required that:

- Each member of the group presents something.
- The presentation has not to be a "slides" version of the report. The focus must be on the elements that are better explained in person. Still, it must cover all elements of the project, including
  - Domain description
  - Process landscape and processes implementation
  - Events sources considered and how these have been processed
  - How the interaction between events and processes took place
  - Challenges, take-home messages, and conclusions
- Each member must be able to answer questions about any part of the project
- The presentation might include a brief live demonstration of the system if you think this can contribute to the better understanding of the project (e.g., in case a phone is generating events, maybe you want to demonstrate this).

After the presentation, questions will be asked to each group member, starting from the project and possibly covering theoretical aspects as well. The timing of the question phase will be announced once precise information about the group is available.

Assessment

The final assessment is based on the group work, the individual presentation and the individual answers provided during the individual discussion.

Appendix: examples of APIs with events

If you decide not to work with the suggested themes, here are some examples of free API describing possible events, which can be used for the project:

- OpenSky REST API: https://openskynetwork.github.io/opensky-api/
- AIS Hub: http://www.aishub.net/api
- Rejseplanen real-time data: https://help.rejseplanen.dk/hc/da/categories/201728005 (and also https://findit.dtu.dk/en/catalog/6083fcacd9001d01701fe6b7)
- Twitter real-time Tweets: https://developer.twitter.com/en/docs/twitter-api/tweets/filtered-stream/introduction
- Current weather conditions: https://openweathermap.org/current
- Facebook web-hooks: https://developers.facebook.com/docs/pages/realtime/
- GitHub events: https://developer.github.com/v3/activity/events/
- Sports events: https://apifootball.com/documentation/ and https://allsportsapi.com/
- Environmental Portal: https://arealinformation.miljoeportal.dk/html5/index.html?viewer=distribution
- Open Data Denmark: https://www.opendata.dk/
- Live energy production and consumption in Bornholm, https://bornholm.powerlab.dk/ and https://bornholm.powerlab.dk/visualizer/latestdata