FAS Simulator – Executive Summary

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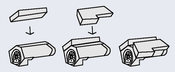
Topic

- Once upon a time, there was a factory.

- The factory had a process.



- The process creates a log file.

Product moved to Workplace 1
Part A attached to Product
Product moved to Workplace 2
Part B attached to Product
Product moved to Workplace 3
Product tested

- Multiple products are going through the factory at the same time.
- The log becomes interlaced.

Product moved to Workplace 1
Part A attached to Product
Product moved to Workplace 2
Product moved to Workplace 1
Part A attached to Product
Part B attached to Product
Product moved to Workplace 3
Product moved to Workplace 2
Part B attached to Product
Product tested
Product moved to Workplace 3
Product tested

- The factory owner adds an internet of things vibration sensors to the equipment, to get information when the equipment is started and stopped. Additionally, there is a periodic clock-type event with periodic ticks unrelated to assembly.
- These events are mixed into the logs along with the process events.

Product moved to Workplace 1
Equipment 1 started
Tick
Equipment 1 stopped
Part A attached to Product
Tick
Product moved to Workplace 2
Product moved to Workplace 1
Tick
Equipment 1 started
Equipment 1 stopped
Tick
Part A attached to Product
Equipment 2 started
Tick
Equipment 2 stopped
Part B attached to Product
Product moved to Workplace 3
Tick
Product moved to Workplace 2
Equipment 2 started
Tick
Equipment 2 stopped
Part B attached to Product
Tick
Tick
Product tested
Product moved to Workplace 3
Product tested

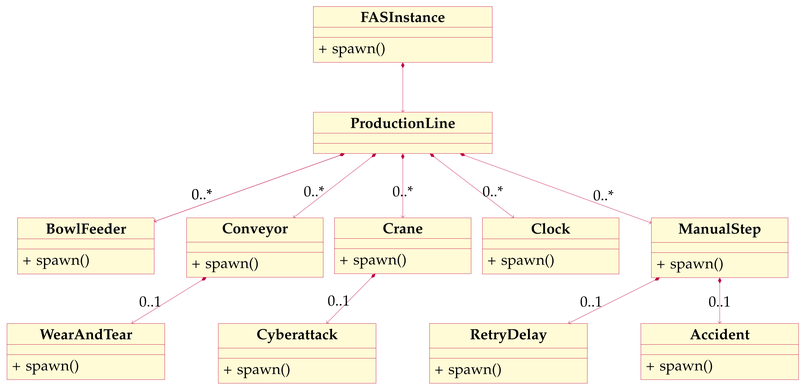
Idea

- If we had a learning system that can learn these kinds of processes from observing the logs, it could alert us if it sees something unexpected.
- How can we support the design of a learning system that is adept at learning process models from symbolic logs?

Discrete Event Simulator

- A Discrete Event Simulator (DES) is a system which simulates a system in an event-oriented fashion.
- The system consists of component processes which wait and send events, and interact.
- The simulation output is a sequence of events with timestamps.
- Different kinds of faults that are currently difficult to detect can be incorporated to the simulation.
- We can generate a lot of logs to get statistically significant measures of the performance of different methods.

Simulator

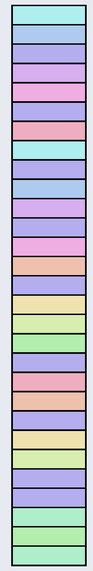


From Simulators to Learning Systems

All kinds of industrial and logistic processes create event logs. The events in these logs are created by different devices, and often we do not know the explicit process model of the processes that create these events.
Wouldn't it be great if we could create a machine learning system that can observe these kinds of logs, and deduce the model of the process?
There are some existing methods for that, but those are very limited. Current methods can only extract an explicit process model from logs when the process instance is identified for each event. The extracted process model is formal and definite and does not capture an intuitive understanding of the process. The formal model only tells us which sequences are allowed and which are not allowed.
Modern machine learning methods can capture intuitive understanding and approximate facts of such processes. For example, a system can observe that the new vibration sensor added is related to the process even if the vibration events are not matched one-to-one to a specific product.

Computer's View to the Log

- As the computer does not know what events correspond to what products, the computer only sees the type of each event without knowing their meaning, like this:



- Each color signifies a different event type.
- It is in principle possible for a computer to discover features of such processes so that deviations can be automatically detected once the normal process has been learned.
- The main challenges are related to randomness inherent in the process and random interlacing of the events in parallel processes.
- A formal process model is not required to detect deviations. It ís enough to discover enough features that define the general process characteristics.