

# EIRES framework for tree-based execution models for gathering real-time patient data

## Abstract

An application area for Complex Event Processing (CEP) in healthcare is for example sensor networks to receive real-time information and to address several goals in healthcare. Patterns in CEP are interesting in certain contexts. This context depends on external data which refers in healthcare to patient's history data. They are mostly stored in electronic health records (EHR) and do often not support the logistics of real-time data entry. The presented EIRES framework shows the need for efficient remote data integration to avoid delays, addressed by combining prefetching and lazy evaluation. Future work is proposed with EIRES for tree-based execution models that define an order of operator evaluation of a hierarchy of buffers. The suggested approach in healthcare context refers to classification and regression where decision trees are a non-parametric supervised learning method.

## Complex Event Processing (CEP)

- = Event, Stream, Event Stream Processing, computational paradigm for pattern detection in streaming event data → enables the system to be more intelligent
- Sources that **produce data continuously event streams**
- Allows to proactively take effective actions

## In Healthcare

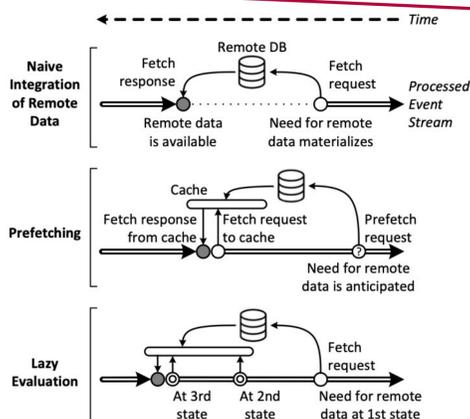
- Healthcare thrives on **real-time information**
- Industry is empowered by technology, a growing number of healthcare management systems are leveraging real-time analytics
- Growth of mobile devices and network connectivity in healthcare: **Sensor Networks** using for effective health monitoring

## Problem

- Patterns are interesting in a certain context → that context depends on **external data**
- To determine events that constitute a query match, their payload may need to be assessed together with data from remote sources. Dependencies are problematic, since waiting for remote data to be fetched interrupts the processing of the stream.
- Huge delay** when querying the remote database when the need for remote data materializes

## In Healthcare

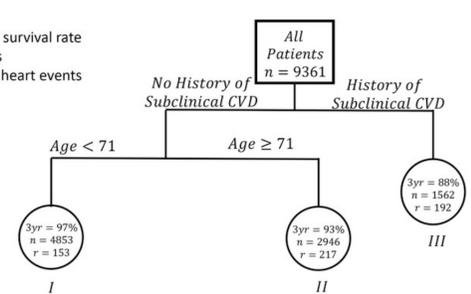
- External data stored in Electronic Health Records (EHR) → **Patient's history** to get a whole picture of patient's needs and to personalize medicine
- Many EHR do not support the logistics of real-time data entry
- Integrating remote data is more difficult in healthcare



Hide remote data transmission latency

- Move the time point when remote data is available ( $t_a$ ) → prefetching
- Move the time point when remote data is needed ( $t_n$ ) → lazy evaluation

Legend  
3yr: estimated 3-year survival rate  
n: number of patients  
r: number of adverse heart events



## Goal

- Need for efficient remote data integration** to address challenge in CEP
- Describing situations of interest in terms of patterns captured by event queries. The queries are evaluated over event stream
- Presented EIRES framework of Prof. Weidlich
  - For efficient integration of static data from remote sources in CEP
  - To determine when to fetch certain remote data elements and how long to keep them in a cache for future use
- EIRES combines strategies **for prefetching and lazy evaluation**

## In Healthcare

- The recording of patient data or charting should occur as near to the care event of that patient as possible
- For patients who need special care and real-time response
- Real-time decisions
- Real-time analytics
- Reducing costs
- Improve healthcare quality
- **Sensor data from wearables**

## Data stored in EHR

- Vital Signs to diagnose conditions
- Recording of clinical data
- Patient assessments
- Observations and actions taken with the patient

## Solution – Future Work

- EIRES for **tree-based execution models** that define an order of operator evaluation of a hierarchy of buffers.
- Decision trees used to represent how different input variables can be used to predict a target value
- It is expected to confirm the experimental results obtained for automata-based models

## In Healthcare

- Tree based models:
  - Decision trees for healthcare analysis are a non-parametric supervised learning method
  - For classification and regression
  - For creating clinical decision tools
- Order of operator evaluation: Grouping and evaluation of expressions for quick decisions for diagnosis/treatment
- Avoiding congestion in wireless sensor networks in healthcare was addressed in past work