Francesco Vitale

Anomaly detection in IIoT systems through data-driven techniques

Tutor: Prof. N. Mazzocca   co-Tutor: Eng. R. Nappi

Cycle: XXXVII   Year: 2021/2022

My background

- I received my M.Sc. in **Computer Engineering** at Università degli Studi di Napoli Federico II

- My research group is the **SECLab research team @ DIETI**

- I started my PhD on November 2021
  - Company-funded scholarship
  - My partner company is **Hitachi Rail S.T.S.**

Research field of interest

- **Data-driven services for Industrial Internet of Things (IIoT) applications**
  - Predictive maintenance
  - Asset monitoring
  - Infotainment
  - ...

- My focus is on **anomaly detection of faulty IIoT systems' behavior**
  - Collective anomalies
  - Time-series data
  - Railway domain
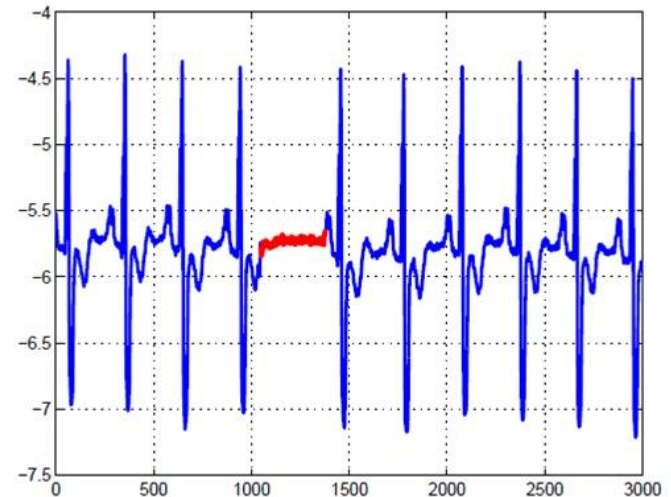
Research activities

- **I studied the state-of-the-art about data-driven techniques for collective anomaly detection in IIoT systems**
  - Main topics: process mining, machine learning, deep learning
  - Secondary topics: embedded systems, virtualization, real-time systems
- **I experimented several approaches for collective anomaly detection through the integration of process mining and machine learning**
  - I validated the approaches applying them to several case studies
    - Public datasets
    - Hitachi "Catenary Inspection System" (CIS) project

Training activities

- **I attended several ad-hoc and computer engineering M.Sc. courses I deemed useful for my research**
  - Modeling complex systems
  - Virtualization technologies and their application
  - Statistical data analysis for science and engineering
  - Real-time industrial systems
  - …

- **I took part in two conferences whose goals were the digital innovation of industry practices and the integration of artificial intelligence in edge systems**
  - National Workshop for Technology Transfer and Higher Education (Verona, 16-17/06/22)
  - 7th Italian Workshop on Embedded Systems (Bari, 23-24/09/22)

Research activity: Overview

- **Problem: which approach should be applied for collective anomaly detection in IIoT systems?**
  - Many alternatives: When are they adequate? For which data? How many resources do we need?
  - Can we reach a trade-off between detection accuracy and other application and contextual requirements?
- **Objective: survey the state of the art about collective anomaly detection in IIoT systems and validate my own approach based on process mining**
- **Methodology: develop a framework for the application of process mining and other data-driven techniques to different types of data and application requirements**
  - Validation on case studies brought by Hitachi and public datasets
  - Comparison with existing approaches on the same data

Products

[P1]	P. Singh, M. Saman Azari, F. Vitale et al., "Using log analytics and process mining to enable self-healing in the Internet of Things" Environ Syst Decis 42, 234–250 (2022). https://doi.org/10.1007/s10669-022-09859-x
[P2]	A prototype for the CIS project to diagnose the train pantograph's behavior throughout its journey (the source code cannot be disclosed)
[P3]	A Java open-source implementation of the token replay conformance checking algorithm providing control-flow and performance diagnostics https://github.com/francescovitale/TokenReplay

Thanks for your attention

Any question?