Luca Maurelli

Data Scientist

Keywords: Signal Processing, Prediction & Filtering, Fault Diagnosis & Prognosis, Time Series & Dynamical models, System Identification & Validation, Visualization

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JOB EXPERIENCE

Ph.D. Student at the Department of Engineering and Applied Sciences

Oct 2019 — Sep 2022
University of Bergamo

1. Theoretical research on the design and estimation of a data-driven direct filters in stochastic frameworks. The proposed approach and the classical solution given by optimal Bayesian filters (KF) is compared in simulation with univariate/multivariate LTI time series and dynamical systems.
2. Project SMART4CPPS, P1 (University of Bergamo, Camozzi), P4 (University of Bergamo, Cosberg, ABB, CNR).
   (a) Management activity and writing of technical reports of P1 and P4.
   (b) Technical activity of Pilot 1: design of a health monitoring system for EM actuators (solenoid valves).
   - White-box modeling of the electro-magneto-mechanical dynamics.
   - Cross-references failure modes, mechanisms and effect analysis and related fault diagnostic variables.
   - Ad-hoc signal processing techniques to clean, normalize, and aggregate experimental big data ($\sim$ 11M).
   - Physical-informed features extraction from significant points of the transient current profile focused on the detection of motion plunger impediment and the energy used upon the actuation.
   - Development of an online prognostic algorithm to detect the remaining useful life of the system.

   (c) Technical activity of Pilot 1: design of a health monitoring system for EM actuators (linear cylinders)
   - Supported selection of sensors for the experimental test bench.
   - Design of the test protocol and calendar scheduling of the acquisition and degradation phases.
   - Acquisition of experimental data and related assessment of the health state of the system.
   - Development of conditional assessment algorithms based on accelerations and current signals using statistical learning routines (Statistical Process Monitoring and Change Point Detection).

   (d) Technical activity of Pilot 4: zero-defect end-of-line tuning of medium-voltage switches
   - Ad-hoc data ingestion phase for the experimental temperature and displacement data.
   - System identification of the coupled grey-box electro-thermal and black-box thermo-mechanical dynamics of the thermal bimetallic component and validation with experimental data.
   - Data augmentation by means of simulating new virtual data. The sampling takes care of the same dependency structure of the experimental data thanks to the statistical Copula distribution.
   - Development of an robust iterative algorithm to tune the end-of-line screw and correct to the desirable trip time by means of an hypothesis on the corrective power bounds.
3. Publication of international journal papers and patents regarding academic and industrial results, see items from [C01] to [P01].

Research Assistant at the Department of Management, Information and Production Engineering

May 2018 — Sep 2019
University of Bergamo

1. Project CRYOABLATION (Dipartimento di Cardiologia, Ospedale di Seriate)
   (a) Modeling of the temperature dynamics in the cryoablation process for atrial fibrillation therapy.
   (b) Model selection using in-sample goodness-of-fit & complexity tradeoff techniques (FPE-AIC-BIC).
2. Project SP@RK-4.0-I.E.S. (Mandelli)
   (a) Supported design of a predictive maintenance system for the acquisition of experimental acceleration signals the fault diagnosis of rotating components (bearings) in high performance work-centers

Researcher & Software Engineer at Consortium Intellimech (Intership during Master's thesis)

Oct 2017 — Apr 2018
Consortium Intellimech

1. Project KNOWLEDGIZE (University of Bergamo, University of Brescia, Cosberg, Elettrocablaggi, Ronzoni)
   (a) Development of a web platform for corporate knowledge management using Django backend framework, Bootstrap and JavaScript frontend libraries, and Google cloud services.
   (b) Automation on the creation of "commesse" PDF documents based on user inputs by using LaTex.
   (c) Creation of a smart search engine based on similar tags on content using ML algorithms related to natural language processing through the word2vec algorithm of the Gensim Python library.
2. Supported development of a monitoring system software prototype in Python:
   (a) Creation of a communication publisher-subscriber infrastructure between gateway and industrial machines through MQTT
   (b) Support to the different communication protocols of the nodes (MQTT, MTCONNECT, UPC-UA, and MODbus) by using Python libraries to parse and encapsulate original messages.

SKILLS & TOOLS

Creation of scientific documents (reports and papers) using LaTeX and LyX. **Management** of scientific references with JabRef. Scientific **computation** and analysis with MATLAB (Parallel toolbox, Optimization toolbox) with external numerical modeler (YALMIP) and solvers (Mosek, GUROBI), and Python libraries (numpy and pandas). Used IDE for Python and LaTeX is VS Code. **Code versioning** with GitHub and Git. Data acquisition HW and SW: NI C-Daq and LabView. Experience with backend framework Django and frontend framework bootstrap. Natural Language Processing with Python library Gensim (vec2word) and Google Cloud Services.

EDUCATION

Ph.D. in Engineering & Applied Sciences, University of Bergamo, Italy
Development of a data-driven direct filter for the design from data filter problem in a stochastic framework Oct 1, 2022

Master's degree in Computer Science & Engineering, University of Bergamo, Italy 110L/110
Development of a Knowledge Management Web Platform with an Innovative ML Algorithm based on Tag Searching Mar 29, 2018

Bachelor's degree in Computer Science & Engineering, University of Bergamo, Italy 105/110
Development of a library for Mobile Robot Trajectory Control Sep 30, 2015

TEACHING EXPERIENCE

Lecture Assistant of the following **MSc courses** at the University of Bergamo:

1. *Controlli Automatici* A.Y. 2018/2019 — italian **exercises**, 20h, Sep – Dec 2018
2. *Controlli Automatici* A.Y. 2019/2020 — italian **exercises/lectures**, 12h, Sep – Dec 2019
3. *Dynamic System Identification* A.Y. 2019/2020 — english **exercises**, 18h, Jan – Jun 2020
4. *Controlli Automatici* A.Y. 2020/2021 — italian **exercises**, 12h, Jan – Jun 2021
5. *Identificazione dei Modelli ed Analisi dei Dati* A.Y. 2020/2021 — italian **exercises**, 12h, Jan – Jun 2021
6. *Controlli Automatici* A.Y. 2021/2022 — italian **exercises**, 12h, Sep – Dec 2021
7. *Identificazione dei Modelli ed Analisi dei Dati* A.Y. 2021/2022 — italian **lectures**, 16h, Jan – Jun 2021

Co-advisor of the following **MSc theses** at the University of Bergamo:

1. *Sviluppo preliminare di un sistema di health monitoring per un attuatore elettromeccanico* (Davide Palazzini, Alen Preda) Mar 2019
2. *Data-driven health monitoring di attuatori elettromeccanici per automazione industriale* (Davide Presciani, Matteo Gusmini) Dec 2019
3. *Simulatore elettro-termo-meccanico di strisce bimetalliche per interruttori industriali a bassa tensione* (Paolo Pasinetti) Dec 2019
4. *Predizione della vita utile residua di valvole elettropneumatiche usando tecniche di machine learning* (Angela Pomata) Apr 2020
5. *Modellazione, simulazione ed auto-tuning di fine linea per interruttori industriali a bassa tensione* (Simone Zanni) Mar 2021
6. *Progettazione di un algoritmo data driven per la predizione della vita utile residua di valvole elettropneumatiche* (Simone Sudati) Jul 2021
7. *Misure di temperatura per la stima della vita utile residua di valvole industriali* (Michele Brillante) Mar 2022

PUBLICATIONS

International conferences

[C01] M. Mazzoleni, M. Scandella, L. MAURELLI, F. Previdi.
Mechatronics applications of condition monitoring using a statistical change detection method
21st IFAC World Congress, Berlin, Germany, July 12-17, 2020 DOI

[C02] L. MAURELLI, M. Mazzoleni, F. Previdi.
Modeling and simulation of bimetallic strips in industrial circuit breakers
19th IFAC Symposium on System Identification, (Virtual) Padova, Italy, July 14-16, 2021 DOI

International journals

[J01] L. MAURELLI, M. Mazzoleni, A. Camisani, F. Previdi.
Physics-informed Remaining Useful Life estimation of cost-effective solenoid valves using significant points of the excitation current
Finished - to be submitted

[J02] L. MAURELLI, M. Mazzoleni, F. Previdi.
Direct Filtering
In preparation

International patents

[P01] L. MAURELLI, M. Mazzoleni, A. Camisani, F. Previdi.
2022 — Brevetto con Camozzi Automation

PRESENTATION LETTER

About me: I like Linux and have experience with the ArchLinux OS. I am interested in personal finance, savings and investments through passive and factor strategies using Exchange Traded Funds. Also, I like both practicing and teaching Badminton as well as self-programming strength training by weight lifting in the gym. I enjoy learning photograph and spending time post-processing pictures.

About work: During my education, I got interested in the engineering of the information process. I

I am interested in signal processing, in particular in data cleaning (outliers and anomalies detection) and transformation techniques (normalization and features selection/extraction/engineering). I like to model time series and dynamic systems in order to solve prediction, forecasting, and filtering problems. I invest time in data visualization to provide an effective way to explore data or to provide powerful insights on data.

Please feel free to contact me if you have any questions. I appreciate your time and consideration.

Sincerely, Luca Maurelli