

Giacomo Boracchi

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Highlights

- Associate professor at Dipartimento di Elettronica e Informazione e Bioingegneria (DEIB – Computer Science), Politecnico di Milano since September 2019;
- 15+ years academic research experience in the field of image analysis / processing. Leader or principal investigator in many industrial research projects concerning imaging and change/anomaly detection.
- My research interests include mathematical and statistical methods for *image processing* and *machine learning* and in particular, image restoration and analysis, change/anomaly detection and learning methods for nonstationary environments. These were published in top journals (TIP, IJCV, PR, TNNLS, NN, TC) and conferences (IJCAI, ICML, ICDM, TCHES).
- Publications: 20 papers in peer-reviewed international journals 4 book chapters, 43 conference and 8 workshop papers. H-index: 22 (1780 cit. in Google Scholar, January 2021). Academic age: 14y.
- Research projects:
 - *Leader* in industrial research projects concerning image analysis/restoration on X-ray inspection machines (with Gilardoni Raggi X), quality inspection in high tech manufacturing (our algorithms are currently monitoring production lines of STMicroelectronics), and anomaly detection in web sessions (with Cleafy).
 - *Principal Investigator*, since 2008, of industrial projects between DEIB and Gilardoni Raggi X, and in the regional-funded project “Checkpoint Integrato” (2012 -2014).
- *Supervisor* of 5 PhD students whose grants were sponsored by companies (STMicroelectronics, Cleafy, Epta) and 1 student sponsored by an Interdisciplinary PhD grant from Polimi (2018 - 2020). Supervisor of 50+ MSc thesis students (current and past).
- Overall fund rising by projects and grants sponsored under my supervision (since 2015): $\approx 1M$ €.
- Established research collaborations with the Laboratory of Signal Processing (Tampere University, Finland, TUNI), the Theoretical Division of Los Alamos National Laboratory (LANL, NM USA), and the Machine Learning Group at Université Libre de Bruxelles (ULB, Belgium). Research visits at TUNI, ULB, Auckland University of Technology (AUT).
- Nokia Visiting Professor Grant, 2017.
- IEEE TNNLS Outstanding Paper Award 2016: “*Just In Time Classifiers for Recurrent Concepts*”
- IBM Faculty Award 2015, *Anomaly Detection in Anatomical Brain Images by Sparse Representations*.
- Teaching PhD courses “*Image Classification*”, “*Advanced Deep Learning*”, “*Learning Sparse Representations for Image and Signal Modeling*” and “*Online Learning and Monitoring*” at Politecnico di Milano
- Teaching MSc course “*Computer Vision and Pattern Recognition*” (2020) at USI, Lugano, Switzerland.
- Associate editor in IEEE Transactions on Image Processing (November 2018) and IEEE Computational Intelligence Magazine (January 2019). Guest Editor in IEEE CIM (2016), and NCAA Springer (2018).

Positions and Education

RECORD OF EMPLOYMENT

September 2019 – present

Associate Professor at Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB, Computer Science) of Politecnico di Milano, Milano, Italy.

January 2020 – September 2020

Contract professor for the *Computer Vision and Pattern Recognition* (2020) course in Università della Svizzera Italiana (USI, MSc students).

September 2016 – August 2019

Assistant Professor (*Ricercatore RTD-b*, tenure track) at DEIB (Computer Science) in Politecnico di Milano.

May 2014 – September 2016

Assistant Professor (*Ricercatore RTD-a*) at DEIB (Computer Science) in Politecnico di Milano.

September 2012 – April 2014

Teaching computer science as a professor during the academic years 2012/13 and 2013/14.

March 2008 – April 2014

Postdoctoral Researcher (“assegnista di ricerca”) at DEI, Politecnico di Milano:

- “*Intelligent mechanisms for the identification and classification of faults and nonstationarities in sensor/actuator networks*” (March 2012 – April 2014)
- “*Design and development of algorithms for detecting non-stationarities in signals and images*” (March 2011 – February 2012).
- “*Design and development of reconstruction algorithms for multiview, possibly calibrated, imaging systems*” (March 2008 – February 2011).

March 2005 – February 2008

PhD student at Dipartimento di Elettronica e Informazione of Politecnico di Milano, Milano, Italy.

September 2004 – February 2005

Researcher at TICSP, Tampere International Centre for Signal Processing, Tampere, Finland, working on “*Adaptive Filtering Techniques for Image Denoising*”.

EDUCATION

- European PhD in Information Technology at Politecnico di Milano, Milano, Italy. May 2008.
Title: “*Motion Blur: Analysis and Restoration*”.
Advisor: *V. Caglioti* (Politecnico di Milano).
Reviewers: *A. Gotchev* (Tampere University of Technology) and *R. Creutzburg* (Brandenburg University of Applied Sciences).
- M.Sc. in Mathematics, at Università degli Studi di Milano, Milano, Italy. April 2004. Grade: 108/110.
Title: “*Biorthogonal Wavelet Basis and The Lifting Scheme in $L^2(\mathbb{R})$* ”.
Advisor: *M. Salvatori*
- Scientific high school diploma from Liceo Scientifico G.B. Vico, Corsico, (Milano), Italy. July 1998.

MAIN RESEARCH VISITS

- Visiting Auckland University of Technology (April 2019).
- Visiting Research Fellow at Computational Imaging Group, Tampere University of Technology (June 2016 - July 2016).
- Research Visit at Machine Learning Group of Université Libre de Bruxelles (September 2015).
- Visiting Research Fellow at Computational Imaging Group, Tampere University of Technology (July 2013 - August 2013).
- Visiting PhD student at Computational Imaging Group, Tampere University of Technology (July 2007 - October 2007).

Since 2008, I regularly visit the Laboratory of Signal Processing at Tampere University for research collaborations concerning computational imaging and image/video restoration algorithms.

Awards and Grants

HABILITATIONS

- HA.1. **National Habilitation as Associate Professor** Sector: 09/H1 “SISTEMI DI ELABORAZIONE DELLE INFORMAZIONI, Professore Seconda Fascia”. December 2016.

AWARDS

- AW.1. **IEEE Transactions on Neural Networks and Learning Systems Outstanding Paper Award 2016** [JR.13]
Cesare Alippi, Giacomo Boracchi and Manuel Roveri “Just In Time Classifiers for Recurrent Concepts“ *IEEE Transactions on Neural Networks and Learning Systems*, vol. 24, no. 4, April 2013, pp. 620 - 634 (TNNLS is a class 1 journal in ANVUR ING-INF/05 and ranked 8 among IEEE journals according to impact factor).
- AW.2. **Best Regular Paper Award** INNS Conference on Big Data 2016 [JR.13]
Cesare Alippi, Giacomo Boracchi and Diego Carrera “CCM: Controlling the Change Magnitude in High Dimensional Data”, *Proceedings of 2nd INNS Conference on Big Data*, October 23-25, 2016, Thessaloniki, Greece, 10 pages
- AW.3. **IBM Faculty Award 2015**
Project Title: *Anomaly Detection in Anatomical Brain Images by Sparse Representations*, Giacomo Boracchi (12K \$).

GRANTS AND SCHOLARSHIPS

- GR.1. **Epic Expert Visits**: grant to support a research visit in Auckland University of Technology (New Zealand) concerning *sequential monitoring schemes in transformed domain* during 2019, 2K €.
- GR.2. **nVidia Hardware Grant**: donation of a Titan V GPU to support our research on data-driven algorithms for analyzing seismocardiogram (2018), permutation tests (2017) and a Tesla K40 GPU to support our research on anomaly detection in images (2015).
- GR.3. **Nokia Visiting Professor**: grant to support a research visit in TUT (Finland) during 2017. Project title: *Foveated Image Features*, Giacomo Boracchi . 6K €.

- GR.4. **CIMO grant** from Center for International Mobility (CIMO), Finland during July 2007 - October 2007 4.8K €.
- GR.5. **INTAS travel grant** for attending at the 16th Jyväskylä Summer School, Jyväskylä, Finland (July 2006).
- GR.6. **MIUR Scholarship** for covering PhD studies from March 2005 until February 2008.

Research Interests

My research interests encompass two different areas: *image processing* and *machine learning*. In particular, my research in image processing concerns mathematical and statistical methods for image restoration and analysis. My research in machine learning focuses on unsupervised learning, and on algorithms for change/anomaly detection, domain adaptation, and for learning in nonstationary environments.

My research interest concerns both in theoretical and applied research, and I am leading industrial research projects referring to both areas. In the field of imaging, we design algorithms for security and quality control applications that are currently employed in X-ray imaging systems of Gilardoni Raggi X, and to monitor high-tech manufacturing lines in STMicroelectronics production sites. I am also leading a project referring to the machine learning domain, where we develop data-driven models to identify malicious web sessions on banking/e-commerce sites, in collaboration with Cleafy.

IMAGE PROCESSING

My research concerns mathematical and statistical methods for image restoration and analysis, and for anomaly detection. In particular, I have been investigating both algorithms for estimating and suppressing degradations in images (noise, blur), as well as computational imaging techniques to design acquisition strategies that ease the image restoration task. My research in anomaly detection is mainly focused on learning data-driven models for locating image regions that do not conform with normal ones, and how to adapt these models when the operating conditions change.

Anomaly Detection: We have been addressing the problem of automatically identifying image regions that do not conform to structures and patterns characterizing a reference normal state, which is defined only through a few training examples. We solved this problem by learning a model that can reconstruct normal regions and detecting as anomalous any sample that can not be explained by this model. To this purpose, we employed dictionaries yielding sparse representations and successfully combined these with statistical detection tools [JR.7] [IC.17]. Dictionaries are very flexible models that we used for anomaly detection and to design adaptation strategies to cope with changes in the operating conditions, like for instance in the magnification level [IC.12]. We have been also investigating anomaly-detection algorithms based on convolutional sparse representations [IC.16], which provides a tighter characterization on normal data. Our anomaly detection framework has been successfully customized and employed to analyse ECG tracings, to detect arrhythmias or electrodes misplacements [JR.3] [IC.10] [PT.1], where models were learned on a user-specific basis, and model-adaptation was triggered by changes in the heart rate. Ongoing work concerns anomaly detection techniques combined with robust fit approaches to detect samples departing from structures identified by a superimposition of multiple geometric primitives, like planes or smooth surfaces.

On this research line, STMicroelectronics has sponsored three PhD grants to students under my supervision over the past few years. I received the IBM faculty award [AW.3] to support this research line and design image-analysis algorithms to monitor the progression of neurodegenerative conditions like Huntington's disease.

Image and video restoration: Assuming that natural images are self-similar (i.e., that their content is redundant), is the prior providing by far the largest potential for image/video restoration. Self-similarity is typically assessed in a nonlocal, patch-wise, manner, and many imaging algorithms extensively compare image patches by means of the weighted Euclidean distance. Inspired by the human visual system, we introduced the foveated patch-distance [JR.9] which mimics the inability of the human visual system to perceive details at the periphery. We have designed general foveation operators, and shown through extensive experiments that non-local image filters measuring the foveated distance outperform their conventional counterparts [JR.9], [IC.23], [WS.4]. Our study therefore indicates that the foveated self-similarity yields a more effective regularization prior than the conventional Euclidean self-similarity.

We also proposed a powerful video filtering paradigm, VBM4D [JR.15], which exploits both temporal and spatial redundancy characterizing natural video sequences: VBM4D achieved state-of-the-art performance in video denoising. Customized denoising algorithms for X-ray multispectral images have been designed within the industrial research projects sponsored by Gilardoni Raggi X S.p.A.

Optimal exposure time for image restoration: In digital photography it is always possible to improve the signal-to-noise ratio of the acquired pictures by increasing the exposure time. However, this is not always a viable solution because of dynamic scenes or camera shakes that would introduce motion blur. In photography the exposure time regulates a trade-off between the amount of blur and noise in the resulting image. Such a trade-off becomes particularly evident at low-light conditions, where short exposures yield images corrupted by an overwhelming noise, while long exposure times produce pictures dominated by blur. Even though the effectiveness of any restoration algorithm combining deblurring and denoising is significantly influenced by the exposure time, none of the existing cameras is able to autonomously set the exposure time in order to ease the restoration task. We have been pioneering computational imaging solutions for determining the exposure time to maximize the quality of the restored image. We have studied the uniform motion blur case [JR.18] through analytical derivations, and we presented a methodology for designing statistical models that predict the restoration performance in case of random motion (including camera shake) [JR.16]. These models can be used to determine the optimal exposure time. We have also investigated the effectiveness of denoising multiple short-exposure images, as an alternative to deblurring a long exposure one [WS.8].

Motion blur analysis: Motion-blurred images embody information about the motion taking place during the acquisition. We devised accurate image-formation models and designed image-analysis algorithms such that a camera can estimate its own 3D motion by analyzing a single blurred image. In particular, we designed algorithms to estimate the 3D motion occurred during the acquisition of a radial-blurred image [JR.20], of a rotationally-blurred image [IC.38], and of a picture depicting a moving ball [IB.4]. These algorithms exploit ad-hoc techniques to adaptively select and analyze salient regions within the blurred images [IC.40]. We presented a deblurring algorithm for radial-blurred images [IC.37], which outperforms other solutions thanks to a spatially adaptive denoising step following the blur inversion. This research activity has been mainly carried out during my PhD.

CHANGE DETECTION AND LEARNING IN NONSTATIONARY ENVIRONMENTS

In the real-world, data often arrive in the form of streams and the process generating them might be nonstationary, i.e., might change over time. Nonstationarities can be due to uncontrollable evolutions of the environment (e.g., in fraud detection, the stream of credit-card transactions continuously change, following customer habits and new fraudulent activities) or unpredictable events (e.g., faults affecting measurements acquired in industrial or environmental monitoring applications). Nonstationary environments (NSE) pose relevant research challenges, and I have been primarily focusing on algorithms for automatically detecting changes – which can provide relevant diagnosing information – as well as adaptation algorithms that are needed when leveraging data-driven models.

Change-detection tests (CDTs) are algorithms that analyze datastreams and detect changes in the data-generating process. One of the most challenging problems in the change-detection literature is the detection

of changes in a stream of i.i.d. data when the pre- and post-change distributions are unknown (nonparametric monitoring). In this direction we have designed a family of nonparametric CDTs [IC.35], [JR.17] based on the Intersection of Confidence Intervals (ICI) rule, which has been also customized for Bernoulli sequences [IC.24] and for distributed systems [IC.28]. We also introduced hierarchical CDTs [JR.8] that perform a high-level validation of each detection. In [IC.11] we have investigated and modelled the intrinsic challenges characterizing change-detection algorithms when input data dimension grows. Lately, my research interests in change detection were mainly devoted to algorithms able to efficiently handle multivariate data-streams, and to this purpose we proposed QuantTrees [IC.5]. We demonstrated that the distribution of test statistics defined over a QuantTree does not depend on the distribution of normal data, and this enables a very practical monitoring scheme, where false positives can be easily controlled.

We have also applied change-detection techniques to different domains such as: cryptography, where we present a sequential monitoring scheme that strengthens side channel attacks [JR.2], environmental monitoring, where we detected tampering attacks to smart cameras [JR.19], [IC.14], smart buildings [JR.10] and water-distribution networks [IC.19] to detect contaminants and leaks, respectively.

Learning in NSE and the Just-in-time (JIT) Adaptation: Data-driven models (like classifiers) can not be straightforwardly used in a NSE. In fact, training and test data might come from two different distributions, and some form of adaptation is necessary to keep the learned model up-to-date and effective.

We have proposed a new methodology to learn in NSEs: the JIT approach. JIT systems implement a *detection - adaptation* paradigm: detection is performed by change-detection test that steadily monitor the input datastream, while adaptation is achieved by specific post-detection procedures that identify, after each detected change, a suitable training set and autonomously adapt to the new process state (i.e., the new concept). One option to gather new training samples is to retrospectively analyze the recent data and estimate the change-time instant: data in between the change-time and the detection-time belong to the new concept. To this purpose, we proposed an iterative algorithm [IC.34] and an ensemble of change-point methods [JR.14] that provide accurate estimates of the change-time instant. Another option to recover training samples is to identify whether some of the previously encountered concepts is equivalent to the new one, and we addressed this problem in [JR.13] [AW.1] by designing either computational representations for concepts and operators to assess their equivalence.

We considered classification as a relevant example of learning problems [IB.1] and introduced a general methodology for designing JIT classifiers [JR.17], which was further developed in [JR.13] to handle recurrent concepts and ensembles of classifiers. JIT classifiers specifically designed for gradually drifting processes are in [IC.32], [IC.36]. A prominent application scenario where we applied our techniques is credit-card fraud-detection [IC.15], [JR.5].

External Research Collaborations

My research has benefited of the following collaborations with internationally renowned researchers:

- Prof. Alessandro Foi and the Computational Imaging Group at Tampere University of Technology (Finland). Our research on image/video processing and computational imaging has been also sponsored by Finnish national projects. Main outcomes: [JR.9], [JR.15], [JR.16], [JR.18].
- Brendt Wohlberg, PhD. from Los Alamos National Laboratory (NM, USA). Research on sparse representations and convolutional sparse models. Main outcomes: [IC.18], [IC.17], [IC.16], and a collaboration as Guest Editors in the special issue “*Model Complexity, Regularization and Sparsity*” of IEEE CIM (November 2016).
- Prof. Gianluca Bontempi and the Machine Learning Group from Université Libre de Bruxelles (Belgium). Research on machine-learning methods for fraud detection, concept-drift adaptation and sam-

pling selection bias. Main outcomes: [IC.15], [JR.5], and I was co-supervising a PhD student from ULB during his visit at DEIB in November 2014 and April-May 2015.

- Guillermo Cecchi, PhD. IBM TJ Watson Lab (New York, USA). Research on anomaly-detection algorithms for automatically assessing the progression of neurodegenerative conditions like Huntington's disease in brain images. Collaboration sponsored by IBM faculty award 2015 [AW.3].
- Pasqualina Fragneto, STMicroelectronics, (Italy). Collaboration on arrhythmia and anomaly detection for health monitoring and quality inspection.
- Cristiano Cervellera, PhD. from Institute Of Intelligent Systems For Automation, CNR (Italy). Research collaboration on unsupervised learning and change-detection for high-dimensional data.
- Prof. Vicenç Puig from Universitat Politècnica de Catalunya, (Spain). Research collaborations within the iSense project on leak/fault detection in water-distribution networks. Main outcomes: [IC.22], [WS.5].
- Michalis P. Michaelides, PhD. from Cyprus University of Technology (Cyprus). Research collaboration started within the iSense project on contaminant/fault detection in smart buildings. Main outcomes: [IC.20], [JR.10].
- Prof. Robi Polikar from Rowan University (NJ, USA). Research on learning in nonstationary environments. Main outcomes [IB.1] and three special sessions on “*Concept Drift, Domain Adaptation & Learning in Dynamic Environments*” jointly organized at IJCNN 2014, 2015 and 2016.
- Dr. Gregory Ditzler from University of Arizona (AZ, USA). Research on learning in nonstationary environments. Joint tutorial “*Learning in Nonstationary Environments: Perspectives and Applications*” at IEEE-SSCI 2015.
- Prof. Dongbin Zhang from Chinese Academy of Sciences (China). Research on change detection using encoding-decoding machines. Main outcome: [IB.2].
- Alessandro Giusti, PhD. from Dalle Molle Institute for Artificial Intelligence (Switzerland). Research on anomaly detection in biomedical imaging. Co-teaching the PhD Course “*Image Classification: Modern Approaches*”, in Polimi, DEIB 2018.
- Ettore Lanzarone, PhD. from Institute of Applied Mathematics and Information Technology, CNR (Italy). Research collaboration on anomaly detection for monitoring the industrial production of nanofibers by analyzing SEM images. Main outcomes: collaboration on AUTOSPIN project.

Scientific Activities and Services

RESEARCH PROJECTS

Gilardoni Raggi X

TYPE: Industrial research project between DEIB and Gilardoni Raggi X S.p.A.

DATE: 2015 - present

TOPIC: Design of an X-ray baggage-inspection system that achieves the new performance standards for airport controls. In particular, the project focuses on computational intelligence and image-processing algorithms for reducing false alarms.

ROLE: *Project Leader* and *Principal Investigator*. I am planning the research activity, coordinating a junior engineer employed at Gilardoni Raggi X, designing algorithms and experiments, developing efficient software prototypes. I wrote the project proposal.

PROJECT LEADER: Prof. Giacomo Boracchi.

STMicroelectronics

TYPE: 3 PhD Grant student sponsored by STMicroelectronics

DATE: 2016 - 2022,

TOPIC: Design of anomaly ad change-detection algorithms for signals and images and in heterogeneous data-streams.

ROLE: *Project Leader* Our algorithms for ECG monitoring have been published in class A conferences (e.g. [IC.7]) and implemented in a prototype device. The anomaly-detection algorithms investigated are currently being ported to monitor STMicroelectronics production.

Cleafy

TYPE: research project and 1 PhD Grant student sponsored by Cleafy

DATE: 2019 – present,

TOPIC: Detection of malicious web sessions by data-driven model.

ROLE: *Project Leader* We are currently investigating data-driven methods to detect anomalous sessions on banks and e-commerce sites protected by Cleafy system. The research mainly involves unsupervised and efficient models.

Smart autonomous broadband laser light

TYPE: Academic, Finnish National

DATE: 2018 - 2019

TOPIC: Development of machine learning models to control and optimize lasers light emission characteristics

ROLE: *External Collaborator*, design of the networks architecture and transfer learning procedures.

LOCAL PROJECT LEADER: Prof. Göery Genty and Prof. Alessandro Foi.

High-performance filtering for scientific imaging

TYPE: Academic, Finnish National

DATE: 2011 - 2016

TOPIC: Development of high-quality image enhancement algorithms for scientific imaging.

ROLE: *Research scientist*, contributing in the investigation of image formation models and the design of image denoising algorithms. In particular, my research focus on image models inspired by the human-visual system, and in particular on the role of foveation in image filtering.

LOCAL PROJECT LEADER: Prof. Alessandro Foi, Tampere University of Technology.

Automated electrospinning plant for industrial manufacturing of functional composite nanofibres (AUTOSPIN)

TYPE: National (CNR and MIUR)

DATE: 2016

TOPIC: Advanced system for monitoring the industrial production of nanofibers.

ROLE: *Collaborator*, design of the anomaly-detection algorithm for SEM images.

LOCAL PROJECT LEADER: Dr. Ettore Lanzarone, CNR, IMATI.

Checkpoint Integrato

TYPE: Industrial, Regional and National Funding

DATE: 2012 - 2014

TOPIC: Design of a new generation checkpoint for security controls. This checkpoint augments X-ray inspection technologies with computer vision and multi-energy X-ray detectors.

ROLE: *Principal Investigator* of the research concerning the detection system in the X-ray baggage-scanning

machine. I have planned and coordinated the research activities, designed the algorithms and experimental campaign, developed software prototypes and discussed the research outcomes with Gilardoni Raggi X staff. Since May 2013 I am supervising a junior engineer employed at Gilardoni Raggi X. I have also contributed in the proposal and technical report preparation.

LOCAL PROJECT LEADER: Prof. Cesare Alippi.

Gilardoni Raggi X

TYPE: Industrial research project between DEIB and Gilardoni Raggi X S.p.A.

DATE: 2008 - 2013

TOPIC: Design of image processing and computational intelligence algorithms to enhance X-ray baggage-inspection systems. In particular, investigating neural models to identify materials from their X-ray absorption (inverse problem), and designing customized algorithms for image enhancement and segmentation.

ROLE: *Principal Investigator*, responsible of the research. I have been designing algorithm and the preparatory experiments, developing software prototypes, preparing technical reports and I was presenting the results and discussing future research directions with Gilardoni Raggi X staff.

LOCAL PROJECT LEADER: Prof. Cesare Alippi.

iSense

TYPE: Academic, European

DATE: 2011 - 2013

TOPIC: Development of intelligent data processing methods for fault detection, isolation and identification.

ROLE: *Research Scientist*, investigating computational intelligence algorithms to automatically detect and diagnose faults in critical systems such as: water-distribution networks, environmental monitoring systems and smart buildings.

LOCAL PROJECT LEADER: Prof. Cesare Alippi.

Non-local modeling of images and vision for compressive sensing and inverse imaging

TYPE: Academic, Finnish National

DATE: 2008 - 2012

TOPIC: Development of non-local image-processing algorithms for compressive sensing and inverse imaging.

ROLE: *Research Scientist*, investigating models to describe how the restoration quality varies with the exposure time in presence of motion. These models allow to automatically define, before image acquisition starts, the exposure time that maximizes the effectiveness of digital image restoration.

PROJECT LEADER: Prof. Alessandro Foi, Tampere University of Technology.

FUNDRISING

Gilardoni Raggi X: Research project on imaging algorithms for X-ray inspection machines, 2015 - 2020, 365K €.

Cleafy: Research project on anomaly detection in web session, 2018 - 2019, 80K €.

Meccanica Del Sarca: Research project on automatic quality inspection, 56K €

T&O Research project on visual recognition 2017 - 2019, 27K €

MecTho Research project on image classification 2017, 20K €

MOX-OFF Research project on sport video analytics 2019, 15K €

IMATI, CNR: Research on “Autospin” project, 2016, 4K €

IBM Faculty Award: project titled “Anomaly Detection in Anatomical Brain Images by Sparse Representations”, 2015 12K \$

ST Microelectronics: 3 PhD scholarship:

“*Change And Anomaly Detection In Multivariate And Heterogeneous Datastreams*”, (2020 - 2022) 75K €

“*Advanced Learning Methods for Anomaly Detection in Signals and Images*”, (2019 - 2021) 70K €

“*Intelligent embedded systems for high-dimensional and high-complexity datastreams*” (2016 - 2018), 70K €

Cleafy: 1 PhD scholarship: “*Anomaly Detection In High-dimensional And Evolving Datastreams*” 73K €

EPTA: 1 PhD scholarship: “*Multimodal and Reference-based Anomaly Detection Algorithms*” 57K €

Polimi: Inter-doctoral PhD scholarship, titled “*Computational Fluid Dynamic and Machine Learning for Diagnosing Complex Systems*”, 2018 - 2020, 70K €

CONFERENCE ORGANIZATION COMMITTEES

- Program Co-chair “*23rd IEEE Multimedia Workshop on Signal Processing*” (IEEE MMSP) 2021.
- Program Co-chair “*22nd IEEE Multimedia Workshop on Signal Processing*” (IEEE MMSP) 2020.
- Program Co-chair “*18th International Conference on Engineering Applications of Neural Networks*” (EANN) 2017.
- Special Session Chair at “*Artificial Intelligence Applications and Innovations Conference*” (AIAI) 2016.
- Publicity co-chair at “*IEEE-INNS Int. Joint Conference on Neural Networks*” (IEEE-INNS IJCNN) 2015.
- Co-organizer of the mini-symposium “*Recent Advances in Convolutional Sparse Representations*” at Siam Imaging Science, 2018.
- Co-organizer of the symposium “*Intelligence for Embedded and Cyberphysical Systems*” in IEEE Symposium Series in Computational Intelligence (IEEE SSCI) 2016, 2015.
- Co-organizer of the special session “*Concept Drift, Domain Adaptation & Learning in Dynamic Environments*” at IEEE-INNS IJCNN 2017, 2016, 2015, and 2014.
- Co-organizer of the special session “*Sequential Learning with Neural Networks*” at IEEE-INNS IJCNN 2016.
- Co-organizer of the symposium “*Intelligent Embedded Systems*” (IES) at IEEE SSCI 2014.
- Co-organizer of the workshop on “*Learning strategies and data processing in nonstationary environments*” at AIAI 2013.
- Co-organizer of special session “*Intelligent Embedded Systems*” at IEEE IJCNN 2013 and 2012.
- Local Chair for the “*IEEE Haptic Audio-Visual Environment and Games*” (IEEE HAVE) 2009.

PROGRAM COMMITTEE MEMBERSHIP

I was part in the TPC of the following scientific events:

- Senior TPC member in “*Int. Joint Conference on Artificial Intelligence*”, IJCAI 2019, 2020 and 2021.
- “*IEEE-INNS Int. Joint Conference on Neural Networks*”, (IEEE-INNS IJCNN) in 2016, 2015 and 2014.
- “*IEEE World Congress on Intelligent Control and Automation*”, (IEEE WCICA 2016) in 2016.
- “*Int. Joint Conference on Artificial Intelligence*”, IJCAI 2015.
- “*Image Processing: Algorithms and Systems*” at IS&T Electronic Imaging, 2017- 2014.
- “*IEEE Int. Instrumentation and Measurement Technology Conference*” (I2MTC), 2016 and 2015.
- “*Int. Workshop on Computational Energy Management in Smart Grids*” 2016 and 2015.
- “*5th Int. Conference on Information Science and Technology*” (ICIST), 2015.
- “*3rd Int. Symposium on Learning and Data Sciences*” (SLDS), 2015.
- “*Int. Conf. on Intelligent Control and Information Processing*”, (ICICIP) 2013.
- “*Int. Conf. on Artificial Intelligence Applications and Innovations*” (AIAI) 2013 and 2010.

Editorial Activities

ASSOCIATE EDITOR

- Associate Editor in IEEE Transactions on Image Processing, since November 2018.
- Associate Editor in IEEE Computational Intelligence Magazine, since January 2019.

GUEST EDITOR

- Guest Editor in the Special Issue of selected papers at EANN 2017, Neural Computing and Applications, Springer, 2018.
- Guest Editor in the Special Issue on “*Model Complexity, Regularization and Sparsity*”, IEEE Computational Intelligence Magazine, November 2016.

REFERRING SERVICES

I have been serving as a reviewer for the following international journals:

- IEEE Transactions on Neural Networks and Learning Systems.
- IEEE Transactions on Neural Networks.
- IEEE Transactions on Image Processing.
- IEEE Transactions on Computational Imaging.
- IEEE Transactions on Circuits and Systems for Video Technology.
- IEEE Transactions on Instrumentation and Measurement.
- IEEE Transactions on Signal Processing.
- IEEE Transactions on Emerging Topics in Computational Intelligence
- IEEE Signal Processing Letters.
- IEEE Embedded Systems Letters.
- Pattern Recognition, Elsevier.
- Neural Networks, Elsevier.
- Neurocomputing, Elsevier.
- Pattern Recognition Letters, Elsevier.
- Computer & Graphics, Elsevier.
- Engineering Applications of Artificial Intelligence, Elsevier.
- International Journal of Computer Vision, Springer.
- Journal of Mathematical Imaging and Vision, Springer.
- Multimedia Systems, Springer.
- Medical & Biological Engineering & Computing, Springer
- SIAM Journal on Imaging Sciences, SIAM.
- Optical Engineering, SPIE.
- Science, Measurement & Technology, IET.
- Computer Science & Technology, IET.
- Image Processing, IET.
- Journal of Electronic Imaging, SPIE and IS&T.

I have been serving as a reviewer for the following international conferences:

- “*IEEE-INNS Int. Joint Conference on Neural Networks*”, (IEEE-INNS IJCNN) in 2010 - 2018.

- “*IEEE Int. Conference on Acoustics, Speech and Signal Processing*” (IEEE ICASSP) in 2013 - 2018.
- “*IEEE Int. Conference on Image Processing*” (IEEE ICIP) 2015 - 2016.
- “*European Symposium on Artificial Neural Networks*” (ESANN) in 2016.
- “*IEEE Symposium Series in Computational Intelligence*” (IEEE SSCI) in 2014 and 2012.
- “*Image Processing: Algorithms and Systems XII*” at Electronic Imaging, (EI) 2014.
- “*European Signal Processing Conference*”, (EUSIPCO) 2014 and 2012.
- “*Int. Conference on Neural Computation Theory and Applications*” (NCTA) 2013.
- “*Int. Symposium on Neural Networks*”, (ISNN) 2011.
- “*Int. Conference on Artificial Neural Networks*”, (ICANN) in 2010, 2009.
- “*Int. Conference on Intelligent Systems Design and Applications*”, (ISDA) 2010.
- “*Int. Workshop on Local and Non-Local Approximation in Image Processing*” in 2009, 2008.

Talks and Tutorials

TUTORIALS

- “*Change and Anomaly Detection in Images, Signals and Datastreams*” at International Conference on Pattern Recognition, ICPR 2020.
- “*Anomaly Detection in Images*” at IEEE International Conference on Image Processing, ICIP 2020.
- “*Anomaly Detection in Images*” at International Conference on Image Analysis and Processing, ICIAP 2019.
- “*Change and Anomaly Detection in Signal, Images, and General Data Streams*” at IEEE International Conference of Acoustic Speech and Signal Processing, ICASSP 2018.
- “*Learning class imbalanced data streams*” at International Joint Conference on Neural Networks, IEEE WCCI IJCNN 2018 Rio de Janeiro, Brazil
- “*Change and Anomaly Detection in Data Streams*” at International Joint Conference on Neural Networks, IJCNN 2017.
- “*Change Detection in Data Streams: Big Data Challenges*” at INNS Conference on Big Data, 2016.
- “*Learning in Nonstationary Environments: Perspectives and Applications*” at IEEE Symposium Series on Computational Intelligence (IEEE SSCI 2015) together with Gregory Ditzler from University of Arizona.
- “*Learning Under Concept Drift: Methodologies and Applications*” at 16th International Conference on Engineering Applications of Neural Networks (EANN 2015).

INVITED TALKS

- “*Workshop on Computer Vision*” Osservatorio AI, Milano, September 2019.
- “*Change Detection in High-dimensional Datastreams*” at Auckland University of Technology and at Waikato University, New Zealand, April 2019.
- “*Change Detection in Multivariate Datastreams: Likelihood and Detectability Loss*” at Tampere University of Technology, Tampere, Finland, May 2016.
- “*Just-in-Time Classifiers for Recurrent Concepts*” at Université Libre de Bruxelles, Bruxelles, Belgium, September 2015.

- “Anomaly Detection with Sparse Representations” at Dalle Molle Institute for Artificial Intelligence, Lugano, Switzerland, December 2014.
- “Change and Anomaly Detection by Means of Sparse Representations” at Tampere University of Technology, Tampere, Finland, September 2014.
- “Foveated self-similarity in nonlocal image filtering” at Università della Svizzera Italiana, Lugano, Switzerland, September 2013.
- “A Brief Overview on Change Point Methods” at Tampere University of Technology, Tampere, Finland, April 2013.
- “Distributed Change-Detection Test in Wireless Sensor Networks” at Tampere University of Technology, Tampere, Finland, June 2012.
- “Modeling the Performance of Image Restoration from Motion Blur” at Tampere University of Technology, Tampere, Finland, June 2011.
- “Change Detection Tests Using the ICI Rule” at Tampere University of Technology, Tampere, Finland, June 2010.
- “Image processing case study for Cuda : LPA-ICI Denoising” at Joint Research Center, Ispra, Italy 27th October 2009.
- “Camera-shake image deblurring: modeling and analysis of the restoration performance” at Tampere University of Technology, Tampere, Finland, February 2009.

Student Supervision

PhD Student Supervision

- *Nicoló Folloni* (2020 - 2022), grant titled “*Change and Anomaly Detection in Multivariate and Heterogeneous Datastreams*”, sponsored by STMicroelectronics.
- *Diego Stucchi* (2019 - 2021), grant titled “*Multimodal and Reference-based Anomaly Detection Algorithms*”, sponsored by EPTA and Assolombarda.
- *Filippo Leveni* (2019 - 2021), grant titled “*Anomaly Detection In High-dimensional And Evolving Datastreams*”, sponsored by Cleafy.
- *Luca Frittoli* (2019 - 2021), grant titled “*Advanced Learning Methods for Anomaly Detection in Signals and Images*”, sponsored by STMicroelectronics.
- *Andrea Schillaci* (2018 - 2020), interdisciplinary grant titled “*Computational Fluid Dynamics and Machine Learning for Diagnosing Complex Systems*”, sponsored by Polimi in conjunction with DAER.
- *Diego Carrera* (2015 - 2018), grant titled “*Intelligent embedded systems for high-dimensional and high-complexity datastreams*”, sponsored by STMicroelectronics.

Visiting PhD Student Supervision

- *Adrià Soldevila Coma* (2016 - 2017), PhD student from Universitat Politècnica de Catalunya, research on leak detection in water distribution networks.
- *Andrea Dal Pozzolo* (2014 - 2015), PhD student from ULB, research on fraud detection [JR.5].

Post-Graduate Student Supervision

- *Filippo Leveni* (2019 - 2020), research on anomaly detection in web access to online banking services and e-commerce.
- *Diego Carrera* (2014 - 2015), research on anomaly detection in images, [IC.16], [IC.17].

Master Degree Thesis Advisor

- 2020** *Davide Rutigliano* (research stage c/o Cisco Photonics, Vimercate), *Francesco Dallanoce*, *Loris Giulivi*, *Antonio Ciusa*, (research stage at Fondazione Don Gnocchi, Milano), *Andrea Strada* (research stage c/o STMicroelectronics, Agrate), *Giacomo Ruffoni*, *Matteo Paltenghi* (research stage c/o CERN, Geneve), *Loris Rossi*, *Gabriele Aldeghi*, *Mattia Di Fatta*, *Daniele Moltisanti*, *Vincenzo Visco*, *Edoardo Gazzaniga*, *Andrea Guglielmetti*, *Lorenzo Fumagalli*, *Luca Guzla*.
- 2019** *Andrea Carminati*, *Semsi Yigit Ozgumus*, *Andrea Carminati*, *Matteo Guidi*, *Robreto di Bella* (Research stage c/o STMicroelectronics), *Pietro Morbidelli* (research stage c/o STMicroelectronics), *Wentai Zhang*.
- 2018** *Nicoló Vendramin*, *Filippo Pedrazzini*, *Luca Frittoli* (research stage c/o STMicroelectronics, Agrate), *Dilana Cinar*, *Filippo Leveni*, *Yinan Zhou*, *Marco Longoni* (research stage c/o STMicroelectronics, Agrate), *Lidia Moioli* (research stage c/o STMicroelectronics, Agrate),
- 2017** *Andrea Bertarini*, *Marco Longoni* (research stage c/o STMicroelectronics, Agrate).
- 2014** *Adriano Gaibotti* (research stage c/o STMicroelectronics, Agrate).
- 2013** *Paolo Moretti*.

Teaching Activities

Here is the list of courses I have been teaching as a Professor.

2020-2021

Learning Sparse Representations for Image and Signal Modeling (*Professor*) - Information Engineering - PhD.

Informatica A (*Professor*) - Mathematical Engineering - Undergraduate.

Informatica (*Professor*) - Civil Engineering for Risk Mitigation (LC) - Bachelor.

Artificial Neural Networks and Deep Learning (*Teaching assistant*) - Computer Science Engineering - MSc.

Image Analysis and Computer Vision (*Teaching assistant*) - Computer Science Engineering - MSc.

2019-2020

Online Learning and Monitoring (*Professor*) - Information Engineering - PhD.

Computer Vision and Pattern Recognition (*Professor*), Master in Artificial Intelligence, Università della Svizzera Italiana, USI, Lugano.

Machine Learning for Non-Matrix Data (*Organizer*) - Information Engineering - PhD.

Computer Vision and Pattern Recognition (*Professor*) - Information Engineering - MSc in USI (Lugano).

Informatica A (*Professor*) - Mathematical Engineering - Bachelor.

Informatica (*Professor*) - Civil Engineering for Risk Mitigation (LC) - Bachelor.

Artificial Neural Networks and Deep Learning (*Teaching assistant*) - Computer Science Engineering - MSc.

Image Analysis and Computer Vision (*Teaching assistant*) - Computer Science Engineering - MSc.

2018-2019

Learning Sparse Representations for Image and Signal Modeling (*Professor*) - Information Engineering - PhD.

Advanced Deep Learning (*Professor*) - Information Engineering - PhD.

Informatica A (*Professor*) - Mathematical Engineering - Bachelor.

Informatica (*Professor*) - Civil Engineering for Risk Mitigation (LC) - Bachelor.

Image Analysis and Computer Vision (*Teaching assistant*) - Computer Science Engineering - MSc.

2017-2018

Image Classification: Modern Approaches (*Professor*) - Information Engineering - PhD.

Informatica B (*Professor*) - Mechanical and Energy Engineering - Bachelor.

Informatica (ICA) (*Professor*) - Civil and Environmental Engineering (LC) - Bachelor.

Image Analysis and Computer Vision (*Teaching assistant*) - Computer Science Engineering - MSc.

2016-2017

Learning Sparse Representations for Image and Signal Modeling (*Professor*) - Information Engineering - PhD.

Learning Sparse Representations for Image and Signal Modeling (*Visiting Professor*) Tampere University of Technology, Faculty of Computing and Electrical Engineering, PhD.

Informatica B (*Professor*) - Mechanical and Energy Engineering - Bachelor.

Informatica (ICA) (*Professor*) - Civil and Environmental Engineering (LC) - Bachelor.

Image Analysis and Computer Vision (*Teaching assistant*) - Computer Science Engineering - MSc.

2015-2016

Informatica B (*Professor*) - Mechanical and Energy Engineering - Bachelor.
Informatica (ICA) (*Professor*) - Civil and Environmental Engineering (LC) - Bachelor.
Image Analysis (*Teaching assistant*) - Computer Science Engineering - MSc.
Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Bachelor.

2014-2015

Informatica B (*Professor*) - Mechanical and Energy Engineering - Bachelor.
Informatica (ICA) (*Teaching assistant*) - Civil and Environmental Engineering (LC) - Bachelor.
Image Analysis (*Teaching assistant*) - Computer Science Engineering - MSc.
Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Bachelor.

2013-2014

Informatica B (*Professor*) - Mechanical and Energy Engineering - Bachelor.
Informatica (ICA) (*Teaching assistant*) - Civil and Environmental Engineering (LC) - Bachelor.
Image Analysis (*Teaching assistant*) - Computer Science Engineering - MSc.
Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Bachelor.

2012-2013

Informatica B (*Professor*) - Mechanical and Energy Engineering - Bachelor.
Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Bachelor.

2011-2012

Informatica B (*Teaching assistant*) - Mechanical and Energy Engineering - Bachelor.
Informatica (ICA) (*Teaching assistant*) - Civil and Environmental Engineering (LC) - Bachelor.
Image Analysis and Synthesis (*Teaching assistant*) - Computer Science Engineering - Bachelor.
Computer Vision (*Teaching assistant*) - Computer Science Engineering (CO) - MSc.
Informatica A (*Lab. supervisor*) - Management and Production Engineering - Bachelor.
Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Bachelor.

2010-2011

Informatica B (*Teaching assistant*) - Mechanical and Energy Engineering - Bachelor.
Informatica (ICA) (*Teaching assistant*) - Civil and Environmental Engineering (LC) - Bachelor.
Image Analysis and Synthesis (*Teaching assistant*) - Computer Science Engineering - Bachelor.
Computer Vision (*Teaching assistant*) - Computer Engineering (CO) - MSc.
Informatica A (*Lab. supervisor*) - Management and Production Engineering - Bachelor.
Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Bachelor.
Control Centre Management: Data Transmission, Analysis and Design for Intelligent Alerting Systems (*Teaching assistant*) - Management and Production Engineering (LC) - Bachelor.

2009-2010

Informatica B (*Teaching assistant*) - Mechanical and Energy Engineering - Bachelor.
Informatica (ICA) (*Teaching assistant*) - Civil and Environmental Engineering (LC) - Bachelor.
Image Analysis and Synthesis (*Teaching assistant*) - Computer Science Engineering - MSc.
Computer Vision (*Teaching assistant*) - Computer Science Engineering (CO) - Bachelor.
Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Bachelor.
Informatica A (*Lab. supervisor*) - Management and Production Engineering - Bachelor.

2008-2009

Informatica B (*Teaching assistant*) - Mechanical and Energy Engineering - Bachelor.

Informatica (ICA) (*Teaching assistant*) - Civil and Environmental Engineering (LC) - Bachelor.

Laboratorio di Analisi delle Informazioni e dei Processi Aziendali (*Teaching assistant*) - Management and Production Engineering - Bachelor.

Image Analysis and Synthesis (*Teaching assistant*) - Computer Science Engineering - MSc.

Computer Vision (*Teaching assistant*) - Computer Science Engineering (CO) - Bachelor.

Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Bachelor.

2007-2008

Laboratorio di Analisi delle Informazioni e dei Processi Aziendali (*Teaching assistant*) - Management and Production Engineering - Bachelor.

Image Analysis and Synthesis (*Teaching assistant*) - Computer Science Engineering - MSc.

Computer Vision (*Teaching assistant*) - Computer Science Engineering (CO) - Bachelor.

Informatica A (*Lab. supervisor*) - Industrial Production Engineering (LC) - Bachelor.

2006-2007

Image Analysis and Synthesis (*Teaching assistant*) - Computer Science Engineering - MSc.

Informatica B (*Lab. tutor*) - Environmental Engineering - Bachelor.

2005-2006

Image Analysis and Synthesis (*Teaching assistant*) - Computer Science Engineering - MSc.

Complete list of publications

PUBLICATION LIST

Refereed international journals _____	20
Refereed international books and book chapters _____	4
Refereed international conferences _____	43
Editorial contributions _____	2
Workshops _____	8
Patents _____	3

BIBLIOMETRY

ACADEMIC AGE: 14 years.

FROM GOOGLE SCHOLAR (QUERY DATE: 2021-01-21)

- Citations (all): 1780; h-index: 22; i10-index: 40
- Citations (since 2016): 1259; h-index: 18; i10-index: 29

FROM SCOPUS (QUERY DATE: 2021-01-21)

- Documents: 71
- Citations: 1126
- h-index: 18

FIVE SELECTED PUBLICATIONS

These are the 5 selected publications that better present my main research activities: [JR.3], [JR.9], [JR.13], [JR.15], [JR.16],

REFEREED INTERNATIONAL JOURNALS

- JR.1. Cristiana Bolchini, Giacomo Boracchi, Luca Cassano, Antonio Miele and Diego Stucchi, "Fault Impact Estimation for Lightweight Fault Detection in Image Filtering" *IEEE Transactions on Computers (TC)* [doi: <https://doi.org/10.1109/TC.2020.3047548>]
- JR.2. Luca Frittoli, Matteo Bocchi, Silvia Mella, Diego Carrera, Beatrice Rossi, Pasqualina Fragneto, Ruggero Susella and Giacomo Boracchi, "Strengthening Sequential Side-Channel Attacks Through Change Detection" *IACR Transactions on Cryptographic Hardware and Embedded Systems (TCHES)* 2020(3), [doi: <https://doi.org/10.13154/tches.v2020.i3.1-21>]
- JR.3. Diego Carrera, Beatrice Rossi, Pasqualina Fragneto, Giacomo Boracchi, "Online Anomaly Detection for Long-Term ECG Monitoring using Wearable Devices" *Pattern Recognition*, Elsevier, In press. [doi: <https://doi.org/10.1016/j.patcog.2018.11.019>]
- JR.4. Diego Carrera, and Giacomo Boracchi "Generating High-Dimensional Datastreams for Change Detection" *Big Data Research* (March 2018), Volume 11, Pages 11-21. [doi: <https://doi.org/10.1016/j.bdr.2017.09.001>]
- JR.5. Andrea Dal Pozzolo, Giacomo Boracchi, Olivier Caelen, Cesare Alippi, and Gianluca Bontempi "Credit Card Fraud Detection: a Realistic Modeling and a Novel Learning Strategy" *IEEE Transactions on Neural Networks and Learning Systems*, August 2018, Volume: 29, Issue: 8 (2018), pp 3784 - 3797. ISSN: 2162-237X. [doi: <https://doi.org/10.1109/TNNLS.2017.2736643>]
- JR.6. Diego Carrera, Giacomo Boracchi, Alessandro Foi, Brendt Wohlberg "Sparse Denoising: Aggregation Versus Global Optimization" *IEEE Signal Processing Letters*, October 2017, Volume: 24, Issue: 10, 1468 - 1472 (2017), ISSN: 1070-9908 [doi: <https://doi.org/10.1109/LSP.2017.2734119>]
- JR.7. Diego Carrera, Fabio Manganini, Giacomo Boracchi, Ettore Lanzarone "Defect Detection in SEM Images of Nanofibrous Materials" *IEEE Transactions on Industrial Informatics*, April 2017, Volume 13, Issu 2, (2017), pp 551 - 561, ISSN: 1551-3203. [doi: <https://doi.org/10.1109/TII.2016.2641472>]
- JR.8. Cesare Alippi, Giacomo Boracchi, Manuel Roveri "Hierarchical Change-Detection Tests," *IEEE Transactions on Neural Networks and Learning Systems*, February 2017, Volume 28, Issue 2 (2017), pp 246 - 258, ISSN: 2162-237X.

- JR.9. Alessandro Foi, Giacomo Boracchi “Foveated Nonlocal Self-Similarity,” *International Journal on Computer Vision, Springer* October 2016, Volume 120, Issue 1 (2016), pp 78 - 110, ISSN: 0920-5691.
[doi: <http://dx.doi.org/10.1007/s11263-016-0898-1>]
- JR.10. Giacomo Boracchi, Michalis Michaelides, Manuel Roveri “A Cognitive Monitoring System for Detecting and Isolating Contaminants and Faults in Intelligent Buildings,” *IEEE Transactions on Systems, Man and Cybernetics: Systems* (2016), 16 pages, accepted, ISSN: 2168-2216.
[doi: <http://dx.doi.org/10.1109/TNNLS.2015.2512714>]
- JR.11. Cesare Alippi, Maurizio Bocca, Giacomo Boracchi, Neal Patwari, Manuel Roveri “RTI Goes Wild: Radio Tomographic Imaging for Outdoor People Detection and Localization,” *IEEE Transactions on Mobile Computing*, October 2016, Volume 15, Issue 10, (2016), pp 1536 - 1233., ISSN: 1536-1233.
[doi: <http://dx.doi.org/10.1109/TMC.2015.2504965>]
- JR.12. Cesare Alippi, Giacomo Boracchi and Manuel Roveri “A reprogrammable and intelligent monitoring system for rock-collapse forecasting“ *IEEE Systems Journal* June 2016, Volume 10, Issue 10, pp 733-744 (2016), ISSN: 1932-8184.
[doi: <http://dx.doi.org/10.1109/JSYST.2015.2429913>]
- JR.13. Cesare Alippi, Giacomo Boracchi and Manuel Roveri “Just In Time Classifiers for Recurrent Concepts“ *IEEE Transactions on Neural Networks and Learning Systems*, April 2013, Volume 24, Issue 4 (2013), pp. 620 - 634, (ISSN: 2162-237X).
Outstanding Paper Award IEEE TNNLS 2016 [AW.1].
[doi: <http://dx.doi.org/10.1109/TNNLS.2013.2239309>]
- JR.14. Cesare Alippi, Giacomo Boracchi and Manuel Roveri “Ensembles of Change-Point Methods to Estimate the Change Point in Residual Sequences“ *Soft Computing, Springer*, November 2013, Volume 17, Issue 11, pp. 1971-1981 (2013), pp. 1971-1981, (ISSN: 1432-7643).
[doi: <http://dx.doi.org/10.1007/s00500-013-1130-7>]
- JR.15. Matteo Maggioni, Giacomo Boracchi, Alessandro Foi and Karen Egiazarian, “Video Denoising, Deblocking and Enhancement Through Separable 4-D Nonlocal Spatiotemporal Transforms “ *IEEE Transactions on Image Processing*, September 2012, Volume 21, Issue 9, (2012), pp 3952 - 3966, (ISSN: 1057-7149).
[doi: <http://dx.doi.org/10.1109/TIP.2012.2199324>]
- JR.16. Giacomo Boracchi and Alessandro Foi, “Modeling the Performance of Image Restoration from Motion Blur “ *IEEE Transactions on Image Processing*, August 2012, Volume 21, Issue 8 (2012), pp. 3502- 3517, (ISSN: 1057-7149).
[doi: <http://dx.doi.org/10.1109/TIP.2012.2192126>]
- JR.17. Cesare Alippi, Giacomo Boracchi and Manuel Roveri “A just-in-time adaptive classification system based on the intersection of confidence intervals rule,” *Neural Networks, Elsevier*, October 2011, Volume 24, Issue 8 (2011), pp.791 - 800 (ISSN: 0893 - 6080).
[doi: <http://dx.doi.org/10.1016/j.neunet.2011.05.012>]
- JR.18. Giacomo Boracchi, Alessandro Foi “Uniform motion blur in Poissonian noise: blur/noise trade-off,” *IEEE Transactions on Image Processing* February 2011, volume 20, Issue 2 (2011), pp.592 - 598, (ISSN: 1057 - 7149).
[doi: <http://dx.doi.org/10.1109/TIP.2010.2062196>]
- JR.19. Cesare Alippi, Giacomo Boracchi, Romolo Camplani, Manuel Roveri, “Detecting External Disturbances on Camera Lens in Wireless Multimedia Sensor Networks,” *IEEE Transactions on Instrumentation and Measurement*, November 2010, Volume 59, Issue 11 (2010), pp. 2982 - 2990, (ISSN: 0018 - 9456).
[doi: <http://dx.doi.org/10.1109/TIM.2010.2047129>]
- JR.20. Giacomo Boracchi, “Estimating the 3D Direction of a Translating Camera From a Single Motion-Blurred Image,” *Pattern Recognition Letters, Elsevier*, February 2009, Volume 30, Issue 7, (2009), pp. 671 - 681 (ISSN: 0167-8655).
[doi: <http://dx.doi.org/10.1016/j.patrec.2009.02.002>]

REFEREED CHAPTERS IN INTERNATIONAL BOOKS

- IB.1. Cesare Alippi, Giacomo Boracchi, Greg Ditzler, Robi Polikar, Manuel Roveri, “Adaptive Classifiers for Nonstationary Environments,” *Contemporary Issues in Systems Science and Engineering, IEEE/Wiley Press Book Series, 2015*
- IB.2. Cesare Alippi, Giacomo Boracchi, Li Bu, and Dongbin Zhao “Encoding-Decoding Machines for Online Concept-Drift Detection on Datastreams,” in *Frontiers of Intelligent Control and Information Processing*, pp. 263-282, Oct 2014 World Scientific Publishing (Singapore), (ISBN: 978-981-4616-87-4)
[doi: http://dx.doi.org/10.1142/9789814616881_0010]

- IB.3. Cesare Alippi, Giacomo Boracchi, Romolo Camplani, Manuel Roveri, “Wireless Sensor Networks for Monitoring Vineyards,” in *Methodologies and Technologies for Networked Enterprises*, (G. Anastasi, E. Bellini, E. Di Nitto, C. Ghezzi, L. Tanca, E. Zimeo, Editors), *Lecture Notes in Computer Science*, 7200, pp 295 - 310, July 2012. Springer. (ISBN: 978-3-642-31738-5).
[doi: http://dx.doi.org/10.1007/978-3-642-31739-2_15]
- IB.4. Giacomo Boracchi, Vincenzo Caglioti, Alessandro Giusti, “Estimation of 3D Instantaneous Motion of a Ball from a Single Motion-Blurred Image,” in *Computer Vision and Computer Graphics. Theory and Applications. Communications in Computer and Information Science*, Springer Berlin Heidelberg, pp. 225-237, (2009) (ISBN: 978-3-642-10226-4).
[doi: <http://dx.doi.org/10.1007/978-3-642-10226-4>]

REFEREED INTERNATIONAL CONFERENCES

- IC.1. Pietro Morbidelli, Diego Carrera, Beatrice Rossi, Pasqualina Fragneto, Giacomo Boracchi, “Augmented Grad-CAM: heat-maps super resolution through augmentation” *2020 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*
[doi: <http://dx.doi.org/10.1109/ICASSP40776.2020.9054416>]
- IC.2. Filippo Leveni, Luca Magri, Giacomo Boracchi, Cesare Alippi “Anomaly detection via preference embedding”, *International Conference on Pattern Recognition (ICPR) 2020*, Accepted
- IC.3. Andrea Schillaci, Maurizio Quadrio, Carlotta Pipolo, Marcello Restelli, Giacomo Boracchi “Inferring Functional Properties from Fluid Dynamics Features”, *International Conference on Pattern Recognition (ICPR) 2020*, Accepted
- IC.4. Roberto di Bella, Diego Carrera, Beatrice Rossi, Pasqualina Fragneto, Giacomo Boracchi, “Wafer Defect Map Classification Using Sparse Convolutional Networks”, *International Conference on Image Analysis and Processing*, 125-136 (ICIAP) 2019, Trento
[doi: http://dx.doi.org/10.1007/978-3-030-30645-8_12]
- IC.5. Giacomo Boracchi, Diego Carrera, Cristiano Cervellera and Danilo Macciò, “QuantTree: Histograms for Change Detection in Multivariate Data Streams”, *International Conference on Machine Learning (ICML) 2018*, Stockholm, Sweden, 8 pages.
- IC.6. Marco Longoni, Diego Carrera, Beatrice Rossi, Pasqualina Fragneto, Marco Pessione, Giacomo Boracchi, “A Wearable Device for Online and Long-Term ECG Monitoring”, *International Joint Conference on Artificial Intelligence (IJCAI) - Demo Track*, 3 pages
- IC.7. Diego Carrera, Beatrice Rossi, Pasqualina Fragneto, and Giacomo Boracchi “Domain Adaptation for Online ECG Monitoring”, *Proceedings of IEEE International Conference on Data Mining*, IEEE ICDM 2017, New Orleans, Louisiana, USA, 6 pages.
- IC.8. Giacomo Boracchi, Cristiano Cervellera and Danilo Macciò, “Uniform Histograms for Change Detection in Multivariate Data”, *Proceedings of International Joint Conference on Neural Networks*, IJCNN 2017, Anchorage, Alaska, USA, 6 pages.
- IC.9. Cesare Alippi, Giacomo Boracchi and Diego Carrera “CCM: Controlling the Change Magnitude in High Dimensional Data”, *Proceedings of 2nd INNS Conference on Big Data*, October 23-25, 2016, Thessaloniki, Greece, 10 pages **Best Regular Paper Award [AW.2]**.
- IC.10. Diego Carrera, Beatrice Rossi, Daniele Zambon, Pasqualina Fragneto, and Giacomo Boracchi “ECG Monitoring in Wearable Devices by Sparse Models”, *Proceedings of European Conference on Machine Learning and Principles and Practice of Knowledge Discovery, ECML-PKDD 2016*, Riva del Garda, Italy, September, 19-23, 16 pages
- IC.11. Cesare Alippi, Giacomo Boracchi, Diego Carrera and Manuel Roveri “Change Detection in Multivariate Datastreams: Likelihood and Detectability Loss”, *Proceedings of International Joint Conference of Artificial Intelligence, IJCAI 2016*, New York, USA, July, 9-13, 7 pages
- IC.12. Diego Carrera, Giacomo Boracchi, Alessandro Foi and Brendt Wohlberg “Scale-invariant Anomaly Detection With Multiscale Group-sparse Models”, *Proceedings of IEEE International Conference on Image Processing, ICIP 2016*, Phoenix, AZ, USA, September 25-28, 5 pages
- IC.13. Giacomo Boracchi, Michalis Michaelides, Manuel Roveri, “Detecting contaminants in smart buildings by exploiting temporal and spatial correlation” *Proceedings of , Intellignce for Embedded and Cyberphysical Systems at SSCI 2015, IEEE Symposium Series on Computational Intelligence, Cape Town, South Africa, December 9 - 12*,
[doi: <http://dx.doi.org/10.1109/SSCI.2015.94>]
- IC.14. Adriano Gaibotti, Claudio Marchisio, Alexandro Sentinelli, and Giacomo Boracchi “Tampering Detection In Low-Power Smart Cameras”, *Proceedings of Engineering Applications of Neural Networks EANN 2015*, Island of Rhodes , Greece, September 25 - 28,
[doi: http://dx.doi.org/10.1007/978-3-319-23983-5_23]

- IC.15. Andrea Dal Pozzolo, Giacomo Boracchi, Olivier Caelen, Cesare Alippi and Gianluca Bontempi “Credit Card Fraud Detection and Concept-Drift Adaptation with Delayed Supervised Information”, Proceedings of *IEEE-INNS International Joint Conference on Neural Networks IJCNN 2015*, Killarney, Ireland, July 12 - 17, [doi: <http://dx.doi.org/10.1109/IJCNN.2015.7280527>]
- IC.16. Diego Carrera, Giacomo Boracchi, Alessandro Foi, Brendt Wohlberg “Detecting Anomalous Structures by Convolutional Sparse Models ” Proceedings of *IEEE-INNS International Joint Conference on Neural Networks, IJCNN 2015*, Killarney, Ireland, July 12 - 17, [doi: <http://dx.doi.org/10.1109/IJCNN.2015.7280790>]
- IC.17. Giacomo Boracchi, Diego Carrera, Brendt Wohlberg “Novelty Detection in Images by Sparse Representations” Proceedings of *Intelligent Embedded Systems at SSCI 2014, IEEE Symposium Series on Computational Intelligence*, Orlando, Florida, December 9 - 12, [doi: <http://dx.doi.org/10.1109/INTELES.2014.7008985>]
- IC.18. Cesare Alippi, Giacomo Boracchi, Brendt Wohlberg, “Change Detection in Streams of Signals with Sparse Representations” Proceedings of *IEEE International Conference on Acoustics, Speech and Signal Processing, ICASSP 2014*, Florence, Italy, May 4 - 9, pp. 5252 - 5256 [doi: <http://dx.doi.org/10.1109/ICASSP.2014.6854605>]
- IC.19. Giacomo Boracchi, Manuel Roveri, “Exploiting Self-Similarity for Change Detection” Proceedings of *IEEE-INNS International Joint Conference on Neural Networks, IJCNN 2014*, Beijing, China July 6 - 11 2014, pp. 3339 - 3346 [doi: <http://dx.doi.org/10.1109/IJCNN.2014.6889860>]
- IC.20. Giacomo Boracchi, Michalis Michaelides, Manuel Roveri, “A Cognitive Monitoring System for Contaminant Detection in Intelligent Buildings” Proceedings of *IEEE-INNS International Joint Conference on Neural Networks, IJCNN 2014*, Beijing, China July 6 - 11 2014, pp. 69 - 76 [doi: <http://dx.doi.org/10.1109/IJCNN.2014.6889452>]
- IC.21. Giacomo Boracchi, Manuel Roveri, “A Reconfigurable and Element-wise ICI-based Change-Detection Test for Streaming Data” Proceedings of *Computational Intelligence and Virtual Environments for Measurements Systems and Applications, CIVEMSA 2014*, Ottawa, Canada, May 5-7 2014, pp. 58 - 63 [doi: <http://dx.doi.org/10.1109/CIVEMSA.2014.6841439>]
- IC.22. Cesare Alippi, Giacomo Boracchi, Vicenç Puig, Manuel Roveri, “An Ensemble Approach to Estimate the Fault-Time Instant,” Proceedings of *International Conference on Intelligent Control and Information Processing*, pp. 836-841, *ICICIP 2013*, pp 836-841 (ISBN: 978-1-4673-6248-1). [doi: <http://dx.doi.org/10.1109/ICICIP.2013.6568188>]
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