**DICHIARAZIONI SOSTITUTIVE DI CERTIFICAZIONI**
    (art. 46 D.P.R. n. 445/2000)

**DICHIARAZIONI SOSTITUTIVE DELL'ATTO DI NOTORIETÀ**
    (art. 47 D.P.R. n. 445/2000)

..la…sottoscritta

**COGNOME**      Bano

*(per le donne indicare il cognome da nubile)*

**NOME**    Saira

**Visto il D.P.R. 28 dicembre 2000, n. 445 concernente "T.U. delle disposizioni legislative e regolamentari in materia di documentazione amministrativa" e successive modifiche ed integrazioni;**

**Vista la Legge 12 novembre 2011, n. 183 ed in particolare l'art. 15 concernente le nuove disposizioni in materia di certificati e dichiarazioni sostitutive *(\*)*;**

**Consapevole che, ai sensi dell'art.76 del DPR 445/2000, le dichiarazioni mendaci, la falsità negli atti e l'uso di atti falsi sono punite ai sensi del Codice penale e delle leggi speciali vigenti in materia, dichiara sotto la propria responsabilità:**

*che quanto dichiarato nel seguente curriculum vitae et studiorum comprensivo delle informazioni sulla produzione scientifica corrisponde a verità*

**Curriculum vitae et studiorum**

**EDUCATION**

**Degree Title:** Doctor of Philosophy in Information Engineering
**Place:** Department of Information Engineering, University of Pisa, Via G. Caruso - 56122 – Pisa (PI), Italy
**Duration:** 02/11/2020- Ongoing
**Thesis:** Distributed Artificial Intelligence for the Internet of Things
**Supervisor:** Prof. Nicola Tonellotto
**Co-Supervisor:** Dr. Alberto Gotta

**Abstract:** The dissertation is dedicated to the development of adaptable and versatile machine learning models for the Internet of Things (IoT) and distributed environments with a wide range of potential applications. This

thesis is built around three main objectives. The first goal was to develop a scalable framework for distributed and **federated learning** that utilizes an in-network caching mechanism with **Apache Kafka** to improve communication efficiency between clients and servers. This work also includes the novel client selection process that reduces bottlenecks, manages communication costs, and optimizes the overall use of computing resources. This system is developed using **Pytorch**, **Python**, **Kafka Python** and **Zookeeper**. The second goal focuses on the development of distributed algorithms for applications such as emotion or stress recognition of drivers, by incorporating **cross-modal knowledge distillation** into the federated learning paradigm. This process involves the transfer of knowledge from a sensor domain to a visual domain on a **resource-constrained** device, optimizing bandwidth utilization and accelerating the federated learning process. In the development of these emotion recognition systems **Tensorflow**, **keras**, **Python** and its libraries such as **Numpy, SciKit** and **Pandas** are used. This work also includes the development of the Artificial Intelligence as a Service **(AIaaS)** toolkit, which consists of a driving session simulated by the **CARLA** software, an **MQTT** broker which is used to publish the driver's facial features and sensor data. A programming tool called Node-Red is used for connecting hardware devices and retrieving the data from the MQTT broker and storing it in the **Influx DB** database. A visual tool called **Grafana** is configured to retrieve the data from Influx DB for graphical visualization and record the driver's synchronized facial features and sensor readings for real-time monitoring. The dissertation also addresses the challenges of scarcity and missing data in federated models by using **generative models** to create synthetic samples and fill gaps in datasets. These generative models effectively capture the underlying data structures and generate missing values, thereby increasing the resilience of the federated model.

**Degree Title:** Master of Science in LM-27 Communications and Computer Networks
**Place:** Department of Electronics and Telecommunication, Politecnico di Torino, Corso Castelfidardo, 39, 10129 Turin TO, Italy
**Duration:** 02/10/2017-28/07/2020
**Thesis:** Experimental analysis of 802.11p boards on real vehicles
**Supervisor:** Prof. Claudio Ettore Casetti
**Co-Supervisor:** Dr. Gianluca Rizzo

**Abstract:** In a master's thesis, real automotive scenarios were tested using APU1D embedded boards that integrated the IEEE 802.11p protocol (an automotive version of'' WIFI"). These boards acted as on- board units in an electric vehicle provided for the study. The main objective was to evaluate an open implementation of IEEE 802.11p, specifically to investigate performance in real-world environments, with particular attention to key performance indicators such as latency and throughput. For data collection, a GPS (global positioning system) device was used to measure the speed and distance of the vehicle, while engine RPM (Revolutions Per Minute) values were obtained via the vehicle's CAN (Controller Area Network) interface. These RPM values were used to estimate the vehicle speed in real time by combining GPS and CAN data and applying various speed filtering techniques, as direct speed information was not readily available via CAN. The aim of the research was to analyze the system performance and identify the strengths and potential issues relevant to real-world mobility scenario.

## SUMMER AND SPRING SCHOOLS:

- **Name: Summer School-University of Pisa 2021**
  **Main Theme:** 5G: Enabling Technologies, Opportunities and Research Challenges Ahead
  **Place:** Department of Information Engineering, University of Pisa, Via G. Caruso- 56122 – Pisa, Italy
  **Duration:** 05/07/2021-10/07/2021
  **Topics:** Artificial Intelligence for 5G Networks and Applications, 5G and UAV applications, non-terrestrial networks for 5G, Cloud/Edge Computing for 5G Networks, The role of 5G on Industrial IoT.

- **Name: Summer School of Information Engineering (SSIE) "Silvano Pupolin"**
  **Main Theme:** Machine Learning, Sustainable Edge Computing and Networking
  **Place:** Department of Information Engineering, University of Padova, Brixen, Italy
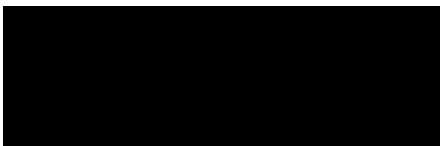
**Duration:** 11/07/2022-15/07/2022
**Topics:** Machine Learning, Federated to Decentralized Learning Architectures, Reservoir Computing for Distributed Systems, pervasive AI, Continual Learning, Graph Neural Networks

- **Name: SatNEx V School 2023**
  **Main Theme:** 'Satellite 6G: Challenges and Solutions', Spring School
  **Place:** Department of Information Engineering, University of Siena, Via Roma 56, 53100, Italy
  **Duration:** 18/04/2023-20/04/2023
  **Topics:** Non-Terrestrial Networks (NTN) System Architecture and Use Cases, The Potential of NTNs for 6G, Edge Computing in NTN 6G networks, QoS/QoE in Satellite Networks for the Future 5G-6G systems, Satellite IoT: Requirements, Architectures, and Challenges.

## WORK EXPERIENCE

**02/11/2020-Current      Research Associate at ISTI-CNR, Pisa, Italy**

The following research activities were undertaken during this period:

- **Part of EU-funded Project TEACHING:** I participated in the TEACHING project funded by the EU H2020 research program GA n. 871385 in which I was responsible for developing Customer Premise Equipment (CPE) to emulate the network parameters in Federated Learning scenario. I also participated in developing the AIaaS (Artificial Intelligence as a Service) toolkit. The toolkit is used to assess the driver's stress level by using facial features and body sensor data (Ref:Conference Proceedings [3]). The development of the toolkit involved the following activities:
  - Capturing facial expression features and body sensor data from a driver using OpenFace and Shimmer frameworks respectively.
  - Configuring the Message Queuing Telemetry Transport (**MQTT**) broker and publishing the facial features and body sensor data to the broker.
  - Configuring Node-Red and **Influx DB**. Node-Red retrieves data from the MQTT broker and deposits the data into the Influx DB database. **KAFKA** could also be used instead of MQTT.
  - Configuring **Grafana**, a visual tool that retrieves data from Influx DB for graphical visualization.

- **Part of European Space Agency (ESA) Project SatNEX:** I participated in the research activities of the Satellite Network of Experts (SatNEx) which is a Telecommunications and Integrated Applications (TIA) agency. We developed a **Machine Learning (ML)** based online traffic classification model (Ref. Conference and Proceedings [6]). The model was developed using **ML classifiers**, **Decision Trees**, **Random Forest**, and **Neural Networks**.

**02/11/2020-Current      PhD Researcher at University of Pisa, Pisa, Italy**

- A comprehensive system for federated learning in IoT is created that optimizes communication efficiency with Kafka. It is tailored to resource-constrained devices, employing multimodal classification and improves the resilience of models through generative neural networks.

**13/02/2017-29/09/2017    Lab Engineer at University of Engineering and Technology, Pakistan**

- Successfully handled the bachelor program lab work including Very Large-Scale Integration and Digital System Design courses.

**03/09/2015-31/01/2017    Research Associate at COMSATS University, Islamabad Pakistan**

- Successfully handled the lab work of Microprocessors, Computer Organization and Digital Logic Design courses.
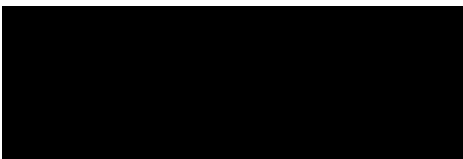
## SKILLS

### Machine Learning/Artificial Intelligence
- Neural networks/deep learning, federated learning, dimensionality reduction, classical machine learning, multimodal classification, generative neural networks, generative adversarial networks (GANs), variational autoencoders (VAE), knowledge distillation, feature learning, feature extraction, decision tree, regression model.
- Environments/Tools: Deep learning frameworks (Tensorflow, keras, Pytorch), anaconda, spyder, pycharm, visual studio, OpenFace

### Data Analysis
- Statistical data analysis, data cleaning, data normalization, data transformation, data visualization, predictive analytics
- Environment/Tools: Python, SciKit, Numpy, Pandas, MATLAB

### Communication & Networking
- Information centric networks, communication efficiency analysis, communication optimization, congestion control, network optimization
- Environment/Tools: Apache Kafka, MQTT, Influx DB, Grafana

### Programming Languages
- Python, C/ C++
- Verilog, VHDL

## PUBLICATIONS

### Journals:
1. Saira Bano, Nicola Tonellotto, Pietro Cassarà, and Alberto Gotta. (2023). Artificial intelligence of things at the edge: Scalable and efficient distributed learning for massive scenarios. Computer Communications, 205,45-57 10.1016/j.comcom.2023.04.010.

2. Saira Bano, Nicola Tonellotto, Pietro Cassarà, and Alberto Gotta. (2023) FedCMD: A Federated Cross-Modal Knowledge Distillation for Drivers Emotion Recognition. ACM Transactions on Intelligent Systems and Technology (under review).

### Conferences:
1. Saira Bano, Nicola Tonellotto, Pietro Cassarà, and Alberto Gotta. Kafkafed: Two-tier Federated Learning Communication Architecture for Internet of Vehicles. In IEEE International Conference on Pervasive Computing and Communications Workshops, pages 515–520. IEEE, 2022, https://doi.org/10.1109/PerComWorkshops53856.2022.9767510

2. Saira Bano, Emanuele Carlini, Pietro Cassara', Massimo Coppola, Patrizio Dazzi, and Alberto Gotta. A Novel Approach to Distributed Model Aggregation using Apache Kafka. In Proceedings of the 2nd Workshop on Flexible Resource and Application Management on the Edge, FRAME '22, page 33–36. Association for Computing Machinery, https://doi.org/10.1145/3526059.3533621

3. Valerio De Caro, Saira Bano, Achilles Machumilane, Alberto Gotta, Pietro Cassarà, An- tonio Carta, Rudy Semola, Christos Sardianos, Christos Chronis, Iraklis Varlamis, et al. Ai-as-a-Service Toolkit for Human-Centered Intelligence in Autonomous Driving. In 2022 IEEE International

Conference on Pervasive Computing and Communications Workshops, pages 91–93. IEEE, 2022 https://doi.org/10.1109/PerComWorkshops53856.2022.9767501

4. Saira Bano, Nicola Tonellotto, and Alberto Gotta. Drivers Stress Identification in Real- World Driving Tasks. In 2022 IEEE International Conference on Pervasive Computing and Communications Workshops and other Affiliated Events (PerCom Workshops), pages 140–141 https://doi.org/10.1109/PerComWorkshops53856.2022.9767455

5. Saira Bano, Pietro Cassarà, Nicola Tonellotto, and Alberto Gotta. A Federated Channel Modeling System using Generative Neural Networks. **Accepted for publication** in Vehicular Technology Conference (VTC), 2023

6. Saira Bano, Achilles Machumilane, Lorenzo Valerio, Pietro Cassará, and Alberto Gotta. Federated Semi-Supervised Classification of Multimedia Flows for 3D Networks. In 2022 IEEE 21st Mediterranean Electrotechnical Conference (MELECON), pages 165–170. IEEE, 2022.
7. https://doi.org/10.1109/MELECON53508.2022.9843104

8. Saira Bano, Nicola Tonellotto, Pietro Cassarà, and Alberto Gotta. FedTCS: Federated Learning with Time-based Client Selection to Optimize Edge Resources, 2022 https://api.semanticscholar.org/CorpusID:252620116

9. Saira Bano, Nicola Tonellotto, and Lorenzo Valerio, "Variational Autoencoders for Noise Resistant Traffic Generation in B5G Networks". 2023 **submitted to** IEEE International Conference on Machine Learning for Communication and Networking.

10. Saira Bano, Achilles Machumilane, Pietro Cassarà, and Alberto Gotta., "Enhancing LOS Estimation in 6G-Non-Terrestrial Networks using Generative Models". 2023 **submitted to** IEEE International Conference on Machine Learning for Communication and Networking.

11. Saira Bano. Ph.D. forum abstract: Efficient Computing and Communication Paradigms for Federated Learning Data Streams. In 2021 IEEE International Conference on Smart Computing (SMARTCOMP), pages 410– 411, 2021 https://doi.org/10.1109/SMARTCOMP52413.2021.00086

## AWARDS AND ACHEIVEMENTS
- **Higher Education Commission of Pakistan scholarship** to study master program at Politecnico di Torino, Italy, 2017
- **Ph.D. Grant by National Research Council, Pisa, Italy** Grant covers the Ph.D. scholarship and all the research cost during the period of my Ph.D research.
- **Best PhD Paper award** at International Conference on Pervasive Computing and Communications (PerCom 2022)
- **RESTART Plenary Workshop participation** at Politecnico di Bari, Italy, July 2023


## SPEAKER/PRESENTER AT CONFERENCES

- **VTC**: IEEE Vehicular Technology Conference in Florence, Italy, 2023
  *Paper: A Federated Channel Modeling System using Generative Neural Networks*

- **PerCom**: International Conference on Pervasive Computing and Communications in Pisa, Italy, 2022
  *Paper: Drivers Stress Identification in Real- World Driving Tasks*
  *Paper: Kafkafed: Two-tier Federated Learning Communication Architecture for Internet of Vehicles*

- **AI6G**: International Workshop on Artificial Intelligence in Beyond 5G and 6G Wireless Networks,

Padova, Italy, 2022
*Paper: FedTCS: Federated Learning with Time-based Client Selection to Optimize Edge Resources*

- **RESTART** Plenary Dissemination Workshop in Bari, Italy, 2023
*Research Proposal: Exploring the Potential of Federated Learning and Generative Models for Channel Modeling in 6G Non-Terrestrial Networks*

## REVIEWER ACTIVITIES

**Reviewer for:**
- IEEE International Conference on Industry 4.0, Artificial Intelligence, and Communications Technology (IAICT), 2021
- Journal of Computing and Digital Systems, 2021
- International Journal of Power Electronics and Drive Systems, 2021
- International Conference on Communication Systems and Network Technologies, 2022
- IEEE ICC Workshop on Edge Artificial Intelligence for 6G, 2022
- International Workshop on Artificial Intelligence in Beyond 5G and 6G Wireless Networks, 2022
- IEEE Workshop on Smart Service Systems (SmartSys), 2022
- IEEE Symposium on Computers and Communications (ISCC), 2022
- IEEE International Conference on Communication, Networks and Satellite (COMNET-SAT), 2023
- IEEE ICC 3rd Workshop on Satellite Mega-Constellations in the 6G Era (6GSatCom-Net'23), 2023
- Elsevier - Computer Communications, 2023
- Journal of Frontiers in Energy Efficiency, section Energy Efficiency Applications, 2023
- Journal of Ambient Intelligence and Smart Environments, 2023

## LANGUAGES

- English : Fluent
- Italian : Basic

## REFERENCES

1. **Name:** Dr. Alberto Gotta
   **Position:** Senior Researcher
   **Organization:** Institute of Information Science and Technologies, Pisa, Italy
   **Email:** alberto.gotta@isti.cnr.it

2. **Name:** Dr. Nicola Tonellotto
   **Position:** Associate Professor
   **Organization:** University of Pisa, Pisa, Italy
   **Email:** nicola.tonellotto@unipi.it
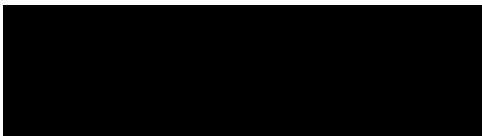
*(\*) ai sensi dell'art. 15, comma 1 della Legge 12/11/2011, n. 183 le certificazioni rilasciate dalla P.A. in ordine a stati, qualità personali e fatti sono valide e utilizzabili solo nei rapporti tra privati; nei rapporti con gli Organi della Pubblica Amministrazione e i gestori di pubblici servizi, i certificati sono sempre sostituiti dalle dichiarazioni sostitutive di certificazione o dall'atto di notorietà di cui agli artt. 46 e 47 del DPR 445/2000*

**N.B:**

**1)** Datare e sottoscrivere tutte le pagine che compongono la dichiarazione.

**2)** Allegare alla dichiarazione la fotocopia di un documento di identità personale, in corso di validità.

**3)** Le informazioni fornite con la dichiarazione sostitutiva devono essere identificate correttamente con i singoli elementi di riferimento (esempio: data, protocollo, titolo pubblicazione ecc…).

**4)** Il CNR, ai sensi dell'art. 71 e per gli effetti degli artt. 75 e 76 del D.P.R. 445 del 28/12/2000 e successive modifiche ed integrazioni, effettua il controllo sulla veridicità delle dichiarazioni sostitutive.

**5)** La normativa sulle dichiarazioni sostitutive si applica ai cittadini italiani e dell'Unione Europea.

**6)** I cittadini di Stati non appartenenti all'Unione, regolarmente soggiornanti in Italia, possono utilizzare le dichiarazioni sostitutive di cui agli artt. 46 e 47 del D.P.R. 445 del 28.12.2000 limitatamente agli stati, alla qualità personali e ai fatti certificabili o attestabili da parte di soggetti pubblici italiani, fatte salve le speciali disposizioni contenute nelle leggi e nei regolamenti concernenti la disciplina dell'immigrazione e la condizione dello straniero.
Al di fuori dei casi sopradetti, i cittadini di Stati non appartenenti all'Unione autorizzati a soggiornare nel territorio dello Stato possono utilizzare le dichiarazioni sostitutive nei casi in cui la produzione delle stesse avvenga in applicazione di convenzioni internazionali fra l'Italia e il Paese di provenienza del dichiarante.