Tenth ITU Kaleidoscope Academic Conference

"Machine learning for a 5G future"

Santa Fe, Argentina, 26-28 November 2018

Final Report

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1. ITU Kaleidoscope 2018 overview

The ITU Kaleidoscope conference 2018 (K-2018) was kindly hosted by the Secretary of Modernization of Argentina, the Government of the Province of Santa Fe and the Universidad Tecnológica Nacional, Santa Fe, Argentina.

Nearly 250 delegates from 18 countries participated at the conference and over 75 participants joined remotely. **Photos** (on the ITU Flickr) and the **webcast** will be available shortly at the event´s webpage.

The event was technically co-sponsored by the Institute of Electrical and Electronics Engineers (IEEE) and the IEEE Communication Society (IEEE ComSoc), and generously supported by the Santa Fe Lottery and NEC.

An 11-month, substantial preparatory process was required for this Kaleidoscope edition. This process involved the efforts and collaboration of six TSB staff, a Steering Committee of five members (SC), and a Technical Programme Committee (TPC) of 83 members, all internationally recognized ICT experts from academia, research institutes and the private sector.

The ITU Secretariat would like to thank the Kaleidoscope 2018 dedicated Steering Committee members: Héctor Mario Carril (ITU-T Study Group 20 Vice-Chairman, Argentina), Christoph Dosch (ITU-R Study Group 6 Vice-Chairman; IRT GmbH, Germany), Kai Jakobs (RWTH Aachen University, Germany); Mitsuji Matsumoto (Professor Emeritus Waseda University, Japan) and Mostafa Hashem Sherif (Consultant, USA); the whole Technical Programme Committee and in particular its Chairman, Mostafa Hashem Sherif, for ensuring transparency through the double-blind peer-review process; and all the partnering organizations which supported the promotion of the conference: Waseda University, the Institute of Image Electronics Engineers of Japan, the Institute of Electronics, Information and Communication Engineers of Japan, the Chair of Communication and Distributed Systems at RWTH Aachen University, the European Academy for Standardization, and the University of the Basque Country; our local partners, Comisión Técnica Regional de Telecomunicaciones, Comisión Interamericana de Telecomunicaciones, Centro Internacional de Investigación Científica en Telecomunicaciones, Tecnologías de la Información y las Comunicaciones, Corporación Universitaria para el Desarrollo de Internet, Centro de Capacitación en Alta Tecnología para Latino América y el Caribe, Universidad Austral, Universidad de Buenos Aires, Universidad de Cuenca, Universidad de Las Américas, Universidad Distrital Francisco José de Caldas, Universidad ICESI, Universidad Nacional de la Plata, Universidad Nacional de Río Cuarto, Universidad Nacional de San Luis, and Universidad Nacional del Sur; and our media partners, Convergencia Latina and the Journal of Big Data and Cognitive Computing.

Special thanks go to Rudy Omar Grether (Dean of the Santa Fe Regional Faculty, Universidad Tecnológica Nacional, Argentina), Kaleidoscope 2018 General Chairman, and to all his collaborators, whose invaluable support contributed to making this conference a great success, in particular: Alfonso Pablo Trevignani, Walter Daniel Justet, María Celeste Weidmann and Juan Pablo Martín.

The Host provided **excellent logistics** and organized several outstanding **social events** throughout the whole conference (cocktail reception, dance spectacles, sightseeing boat trips, visits to the local brewery and a fascinating and educational visit to a local Data Centre).

Alessia Magliarditi, ITU Kaleidoscope Coordinator, chaired the meeting of the Award Committee that selected the winners of the awards for the three best papers. The Award Committee was composed of five conference attendees: Joan Garcia-Haro (Technical University of Cartagena, Spain), Eva Ibarrola (University of the Basque Country, Spain), Mostafa Hashem Sherif, Duncan Sparrell (Consultant, USA) and Tomás Bracalenti (Universidad Tecnológica Nacional, Santa Fe Regional Faculty, Argentina). At the Ceremony, Alessia announced the winners of the best paper awards and the recipients of the Young Author Recognition whose certificates were kindly delivered by Chaesub Lee (Director, Telecommunication Standardization Bureau (TSB), ITU), Rudy Omar Grether, Hugo Miguel (Under Secretary of Planning, Information and Communications Technologies Secretariat, Modernization Government Secretariat, Argentina), Maria Victoria Sukenik (Modernization Government Secretariat, Argentina) and Héctor Mario Carril (ITU-T Study Group 20 Vice-Chairman, Argentina).

At the Closing Session, the TSB Director, together with all the participants of the Award Ceremony, gave their closing remarks and Alessia presented some highlights of the conference and thanked all the people that contributed to its success, in particular Héctor Mario Carril, Maria Victoria Sukenik, Alfonso Pablo Trevignani (Kaleidoscope 2018 local focal point), her team, Emer Windsor, Erica Campilongo and Simiso Dlodlo, as well as Matt Dalais (Communications Officer), Pascal Borde (promotional collaterals) and Ilia Londo (IT support) from the ITU Telecommunication Standardization Bureau.

2. Conference programme

The Opening Ceremony included welcome remarks from Rudy Omar Grether (Dean of the Santa Fe Regional Faculty, Universidad Tecnológica Nacional, Argentina and ITU Kaleidoscope 2018 General Chairman), Ignacio Tabares (Secretary of Technologies for Management and Government of the Province of Santa Fe, Argentina), Chaesub Lee (Director, Telecommunication Standardization Bureau, ITU), Hector Huici (Secretary of Information Technologies and Communications, Argentina), and Pablo Gustavo Farías (Minister of Government and State Reform of the Province of Santa Fe, Argentina).

After the opening addresses, Hugo Miguel (Under Secretary of Planning, Information and Communications Technologies Secretariat, Modernization Government Secretariat, Argentina) introduced a keynote speech on the Impact of machine learning in the 5G planning and deployment [Presentation]. This session was moderated by Maria Victoria Sukenik (Modernization Government Secretariat, Argentina).

The keynote summary is available on pg. 19 of the Conference proceedings.

In addition to the keynote speech, the programme included two **invited papers:**

"A Machine Learning Management Model for QoE Enhancement in Next Generation Wireless Ecosystems" [Presentation] – which focused on the key role that Big Data analytics and Machine Learning are expected to play in enhancing quality of experience in next-generation wireless ecosystems. This invited paper was authored by Eva Ibarrola (Professor, University of the Basque Country-UPV/EHU, Spain); Mark Davis (Dublin Institute of Technology (DIT), Ireland); Camille Voisin and Ciara Close (3OptiWi-fi, Ireland); Leire Cristobo (University of the Basque Country-UPV/EHU, Spain).

"Machine Learning Opportunities in Cloud Computing Data Center Management for 5G Services" [Presentation] - Machine Learning for data management shows significant potential to support cloud-optimized 5G networking, particularly by improving critical resource-management decisions with two-phase optimization schemes for virtual machine placement. This invited paper was authored by Fabio López-Pires (Itaipu Technological Park, Paraguay); Benjamín Barán (National University of the East, Paraguay).

Forty-seven papers from 18 countries were submitted for review, 15 of which were accepted for publication and presentation from 9 countries (almost all from academic circles).

The research results submitted are related to various ITU activities, including: Machine learning for network operation and management; Machine learning in software defined networking (SDN) and network function virtualization (NFV); Information mining or traffic classification and botnet detection, predictive fault analysis, fraud detection; Data analytics, network management and orchestration; Machine learning in cloud-based networks; Use cases and requirements of network intelligence; Application of artificial intelligence algorithms for big data analysis in 5G networks for intrusion detection; Prediction of subscribers' behaviour and churn; Performance monitoring and big data analysis; Standards for machine learning in self-organizing networks (SON); Protocols and standards for network information mining including data semantics, interoperability, and search tools; Machine learning and standardization for fault-tolerant networks; Resource allocation for shared/virtualized networks using machine learning; Security, performance, and monitoring applications using machine learning; Machine learning for Internet of things (IoT); Machine learning for industry, government and society; Machine learning for smart sustainable cities; Learning-based network optimization; Experiences and best-practices

using machine learning in operational networks; Implications and challenges brought by computer networks to machine learning theory and algorithms; Regulation, standardization and professional codes of conducts in machine learning; Ethical issues in machine learning; How to establish trust in machine learning outcomes; and Effects of machine learning on liberal arts education. As in previous editions of the conference, a number of papers addressed radio-related issues such as Machine learning in radio and wireless networks; Spectrum allocation schemes with machine learning algorithms; Machine learning automatic provisioning, resource allocation and configuration including antenna.

Presenters made reference to ITU-T Recommendations (Rec. G.1000 "Communications Quality of Service: A framework and definitions" - SG 12; Rec. E.804 "Quality of service aspects for popular services in mobile networks" - SG 12; Rec. E.802 "Framework and methodologies for the determination and application of QoS parameters"; Rec. P.1203.1 "Standardization of future audio-visual streaming services over wireless IP network" - SG 12; Rec. J.247 "Objective perceptual multimedia video quality measurement in the presence of a full reference" - SG 12; Rec. H.264 "Advanced video coding for generic audiovisual services" – SG 16; Rec. M.3400 "TMN Management functions" – SG 2; Rec. Y.3102 "Framework of IMT-2020 network" - SG 13; ITU-T Rec. F.743.1 "Requirements for intelligent visual surveillance" –SG 16; ITU-T Rec. X.1157 "Technical capabilities of fraud detection and response for services with high assurance level requirements" – SG 17); ITU-R Recommendations (Rec. M.2083-0 "IMT Vision - Framework and overall objectives of the future development of IMT for 2020 and beyond" – ITU-R SG 5; Report ITU-R M.2413-0 "Reception of automatic dependent surveillance broadcast via satellite and compatibility studies with incumbent systems in the frequency band 1 087.7-1 092.3 MHzWP5B" – ITU-R SG 5); study group activities (ITU-T SG 12 - Performance, QoS and QoE; ITU-T SG 13 - Future networks (& cloud); ITU-T SG 16 – Multimedia); focus group activities (ITU-T Focus Group on Machine Learning for Future Networks including 5G (FG-ML5G); ITU-T Focus Group on Data Processing and Management to support IoT and Smart Cities & Communities (FG-DPM)); etc.

An overview of Kaleidoscope papers and a mapping of papers and ITU activities (i.e. Study Groups, Focus Groups, etc.) has been prepared for the coming meeting of the ITU Telecommunication Standardization Advisory Group (TSAG), and also for the next ITU Radiocommunication Advisory Group (RAG) and the ITU Telecommunication Development Advisory Group (TDAG). Temporary documents providing information on selected papers will be also submitted to the various ITU Study Groups for consideration in their activities.

The authors of the award winning papers shared the prize fund of 6,000 CHF.

- **1st prize** (CHF 3 000.-): *"Consideration on Automation of 5G Network Slicing with Machine Learning"* [Presentation]

Authors: Ved P. Kafle, Yusuke Fukushima, Pedro Martinez-Julia and Takaya Miyazawa (National Institute of Information and Communications Technology, Japan)

The winning paper highlights Machine Learning's potential to offer valuable support to automated 5G network slicing, contributing to the allocation and adjustment of network slices' computing and network resources in tune with different service requirements and time-varying network workloads.

- **2nd prize** (CHF 2 000.-): *"A Gendered Perspective on Artificial Intelligence"* [Presentation]

Author: Smriti Parsheera (National Institute of Public Finance and Policy, New Delhi, India)

The 2nd prize paper proposes three actions to correct imbalanced power structures in Artificial Intelligence: develop standards for Artificial Intelligence incorporating the concept of 'fairness by design'; invest in research and development to formulate technical tools to translate ethical principles into practice; and strive towards datasets free of bias.

- **3rd prize** (CHF 1 000.-): *"Ethical Framework for Machine Learning"* [Presentation]

Authors: Charru Malhotra (Indian Institute of Public Administration, India); Vinod Kotwal (Department of Telecommunications, India); Surabhi Dalal (India Centre for Migration, India)

The paper analyzes the interplay of ethics and Machine Learning with a view to preventing machines from inadvertently adopting unethical behaviour. The paper proposes the introduction of an 'ethical algorithm' in the Machine Learning domain as well as a conceptual framework to resolve ethical dilemmas.

Alongside the winners of cash prizes, 8 entrants received **Young Author Recognition Certificates:** Emilia Gibellini (Telecom Argentina, Argentina), Luis Miguel Tuberquia David (Universidad Distrital Francisco José de Caldas, Colombia), Ruben Martinez Sandoval (Technical University of Cartagena, Spain), Sebastian Canovas-Carrasco (Technical University of Cartagena, Spain), Bruno Marengo (Universidad Tecnológica Nacional, Argentina), Juan Pablo Prina (Universidad Tecnológica Nacional, Argentina), Pamela Ferrari Lezaun (Universidad Tecnológica Nacional, Argentina) and Gustavo Olivieri (Universidad Tecnológica Nacional, Argentina).

All papers presented at the conference are included in the Conference proceedings, which are freely available for download on the Kaleidoscope 2018 webpage. They will be also listed in the IEEE *Xplore* digital library.

Programme, **presentations, abstracts** and **biographies** are available online.

Relevant recommendations and conclusions from the technical sessions, as drafted and presented by the Session Chairs, are available online in PDF format on the programme webpage, **Wrap up session**.

The conference programme also included three **Tutorials**.

The first Tutorial was on "*Artificial Intelligence: Pros and Cons*". Three professors from the CIDISI Research Center, Universidad Tecnológica Nacional, Argentina, Maria de los Milagros Gutiérrez, Luciana Ballejos and Maria Guadalupe Gramajo introduced Artificial Intelligence (AI) as a discipline of computer science that is growing exponentially. Its transformation power already impacts people lives, making things smarter and smarter. AI emerges as a tool that helps human beings to solve problems that for years could not be tackled, and to carry out activities more efficiently and in a better way. However, there are some challenges that must be addressed, such as transparency, security and trust. While opportunities are great, some risks arise. In this context, new fears have emerged, such as the possibility of losing control over AI tools, and its consequences. In recent years, there have been examples of these types of threats. Even though this field of research is still developing, it is already driving the new industrial revolution. In light of this, it will be necessary to make users aware of the pros and cons of AI, in order to promote its benefits and its use for good. [Presentation]

The second Tutorial on *"Pattern Recognition"* was organized and presented by Juan Pablo Martín (Research Group Director Communications, Universidad Tecnológica Nacional, Facultad Regional San Nicolás, Argentina) The objective of this tutorial was to understand the most recent pattern recognition methods and their implementation. It also included a brief summary on the learning problems, adjustments needed, least squares methods, k-nearest neighbours and support vector methods, variables selection and non-supervised learning techniques. [Presentation].

The third Tutorial, addressed the question *"Can Artificial Intelligence Give a Mind to Machines?"*. Hugo Leonardo Rufiner (Full Professor, Informatics Department, National University of Litoral (FICH-UNL), Argentina) explained as throughout history, the mind has been conceived and defined in different ways. At present, functionalism has associated the mind-brain duality more strongly with the "equivalent" software-hardware concepts in the field of computer science. The enormous evolution of software through Artificial Intelligence has allowed us to emulate several aspects of human intelligence. This seems new, however, it has been the motivation for this discipline since its inception. An important milestone in this evolution is the bio-inspired techniques of deep learning that have made it possible to improve the performance of algorithms in various tasks and the implementation of practical systems of artificial intelligence for general purposes. However, can this evolution come to endow our computers with a real mind? Can we, for example, give them a conscience? From interactions with colleagues from diverse disciplines, several possible scenarios relating to these questions have been raised, some of which have been analyzed in this tutorial. [Presentation]

The eight edition of the **Jules Verne's corner (JVc)** entitled "*The Future of Work and the Future of Privacy in the Era of Artificial Intelligence*", was moderated by Ana Rosa Tymoschuk (Secretary of Science and Technology, Universidad Tecnológica Nacional, Facultad Regional Santa Fe, Argentina) and featured two panelists: Erica Hynes (Minister of Science, Technology and Productive Innovation of Santa Fe, Argentina) [Presentation], and María Laura Spina (Ordinary Adjunct Professor, UTN Santa Fe, Argentina) [Presentation].

Media coverage and relevant interviews are available in Spanish in El Litoral, Santa Fe Government Portal, and Diario la Opinion. The ITU published daily highlights on the ITU News portal.

3. Side event – Local Universities Exhibit

The Local Universities Exhibit was organized locally by Juan Pablo Martín (Research Group Director Communications, Universidad Tecnológica Nacional, Facultad Regional San Nicolás, Argentina), and by Erica Campilongo (TSB). Universities from the Region were invited to present, in parallel with the plenary conference sessions, their academic research, special projects, and literature. As follows, please see the list of the Exhibitors and a brief description of their showcases:

- Universidad Nacional de La Plata (Argentina)

The Universidad Nacional de La Plata presented the E-Waste Program that works with electronics and electrical scrap devices, with social and environmental goals. Also, as an example, a parking solution developed by the "Centro Superior para el Procesamiento de la Información (CeSPI)", was presented which has been implemented by the City Government.

- Universidad Tecnológica Nacional, Facultad Regional Santa Fe (Argentina)

Information was presented on all the courses that the School offers. Also, a programmable robot was showcased. The robot recognizes the surrounding terrain through sensors and decides the shortest path to a given point avoiding obstacles. Furthermore, the University used electrical power obtained from solar array, and one of the panels was displayed.

- Universidad Nacional de San Luis (Argentina)

On display was the academic offer that is proposed for 2019, for undergraduate and graduate careers; in the areas of knowledge of social and human sciences, basic sciences and applied sciences, which includes engineering. Additionally, information was provided with a focus on the careers that are available at the Department of Electronics and the applied researches with focus on artificial vision, digital control, embedded systems, Internet of things, signal acquisition and digital processing, wireless sensors network, and applications for agriculture based ICTs.

- Universidad Austral (Argentina)

This exhibit showed prototypes regarding different use cases for deep learning in video analysis, to be used for traffic optimization in smart cities and security systems. These projects were developed by computer engineering students from the Universidad Austral.

- Universidad Distrital Francisco José de Caldas (Colombia)

The University displayed the initiative of using ICTs to construct sustainable communities in vulnerable situation, using as a base the UN SDG 2030. They believe that establishing a bridge between different fronts is the academic challenge and the fundamental proposal to create an ABC-G-OT (Academy, Business, Community, Government and Other communities in the territory). They added "It is important to highlight the role of democratization of technologies, which well treated, may turn out in a catalyst".

The Universidad Distrital Francisco José de Caldas, Bogotá Colombia, invited all Kaleidoscope participants to the forum "FUTURO DE LAS TECNOLOGÍAS SOCIALES EN LA REGIÓN AMÉRICAS", Living Lab Verbenal Sueña", from 8 to 12 April 2019.

- Universidad Nacional del Litoral (Argentina)

Several Schools presented their research work, including:

- School of Medicine (Center of Studies of Training and Innovation for the Teaching of Health Sciences - CEFIECS); 3D printing of sections of bones, development in virtual and augmented reality technologies for medical simulation for training and teaching in health sciences and telemedicine for rural areas.
- School of Architecture, Design and Urbanism (Beta Team); development of applications of augmented reality for pedagogical purposes for the awareness of agrochemicals and biopreparations impacts.
- School of Architecture, Design and Urbanism (Guardianes del Río); Education project to establish a self-sufficient tourism program as a community development strategy in an insular territory.
- School of Engineering and Water Resources (FICH - Centre of Water and Hydro-Environmental Research - CENEHA); development of a redundant communication network for a Flood Warning System (FEW) relying on low-cost single board computers and routers that reduce the communication expenditure of an official current satellite system significantly; this cost-efficient technology is adequate to increase the reliability of any FEW of similar characteristics.
- School of Engineering and Water Resources (FICH - Dept of Computer Sciences); Pilot E-Waste Treatment System in the city of Santa Fe, Argentina - Recuperando Futuro; with a proper treatment of e-waste from computer equipment, a project was generated to contribute to the inclusion of young people in a situation of social vulnerability and labour disadvantage, aimed to introduce them back into the real labour sphere.

4. Next Kaleidoscope

The theme and all relevant information for the 11th edition of the ITU Kaleidoscope academic conference will be made available soon here.

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