Newsletter

Number 5, July 2023

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COST CA20120 ACTION

INTERACT

IN THIS ISSUE:

EDITOR'S ADDRESS

Dear reader,

I would like to announce the fifth issue of the INTERACT Newsletter!

This issue appears after the fifth technical meeting in Barcelona. Therefore, you will find highlights from all working groups. Some of these groups are preparing white papers and INTERACT sessions or workshops on international events so the discussions were vivid :)

In this issue the floor is given to Sana Salous, Professor at Durham University (United Kingdom) who is the originator of the Women in Radio Science initiative and Diego Dupleich

Agnieszka Czapiewska
Gdańsk University of Technology, Poland

from Technische Universität Ilmenau Germany, a subworking group "mmWave and THz sounding" chair.

There are also some announcements about available grants and the upcoming COST INTERACT Machine Learning Challenge.

Enjoy the reading!

ABOUT COST

This COST Action aims at contributing to the societal transformation, by developing the next generation of radio communication networks, 6G.

The Intelligence-Enabling Radio Communications for Seamless Inclusive Interactions (INTERACT) vision is to go beyond the capabilities of the 5G and to make the radio network itself intelligent, meaning aware, adaptive and parsimonious.
Challenges include:

1) Fundamental research in the fields of antennas and propagation, signal processing and localization, network architectures and protocols, to design intelligent-enabling radio communications;
2) Exploitation of Machine Learning tools for the implementation of many aspects of this network intelligence;
3) Collecting real-world data and making them available to the research community by building the INTERACT datasets.

**This COST action started in October 2021 and ends in October 2025.**

5th MCM & Technical Meeting - Barcelona 2023

May 24th, 2023, Barcelona (Spain) - the newcomers' photo.

2nd Training Day
Recent Advances in Data Engineering for Networking

The day before the 5th MC and technical meeting in Barcelona (Spain) a training day was held which covered an in-depth study of convergence of data engineering in network management and the orchestration domain. These topics were presented by Engin Zeydan and Josep Mangues from Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Barcelona (Spain).
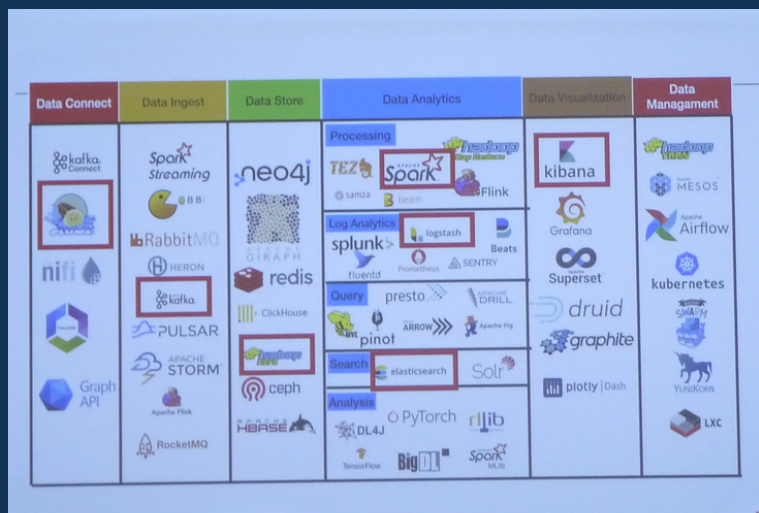
Slide from the presentation showing available tools for solving network managmenet problems.

During the training day, the participants were given background information on data engineering of telecommunication networks.. There was also a step-by-step demo.

CHAIRMAN'S ADDRESS

"INTERNET OF THINGS"

Summer holidays are just around the corner. And July comes with its share of events, some predictable and recurring like the Tour de France; some feared but expected like the fires; and some unexpected and dramatic like the death of Naël in France and the ensuing riots.

When I think of these events, my mind wanders to the IoT [don't ask me why], to sensor networks and to the many works that have focused on these application frameworks - sport, forests, crisis situations... I think of a book from 2004 - "Sensor networks: a bridge to the physical world" by Jeremy Elson and Deborah Estrin. The book opens with a fictional story of an earthquake in Southern California and the contribution that sensor networks could make in this case.

I then think back to what, to my knowledge, was one of the very first sensor networks deployed - 1969, Operation Igloo White. A military and war context, which unfortunately comes as no surprise. And two difficult issues: recovering information from sensors scattered in the jungle, so with no infrastructure, and the lifespan of the objects, just under an hour at the time - and that wasn't because of miniaturisation constraints.

And in the end, I say to myself that we're still at the same point - reliability, energy. And that sensor networks are still a long way from the promises announced despite intensive research for over 25 years now. So what are we waiting for? Are 5G and NB-IoT the missing piece? The time has come to break down this challenge. Let's do it.

Have a good break.

INTERVIEW WITH A SENIOR RESEARCHER:
SANA SALOUS

PROFESSOR AT DURHAM UNIVERSITY (UNITED KINGDOM)

After graduating with BEE from the American University of Beirut, MSc and PhD from Birmingham University, she joined academia first in Jordan for four years, then back in the UK taking up positions at Liverpool University and the University of Manchester Institute of Science and Technology. Since 2003 she have been Professor of Communications Engineering at Durham University and an active member of the International Union of Radio Science, currently leading its initiative on Women in Radio Science and UK chair.

What was your motivation to become a researcher?
I was fortunate to have joined Birmingham University for my postgraduate studies which at the time had one of the leading radio research groups in remote sensing and high frequency propagation. Interacting with the research group during my MSc research project and with encouragement from colleagues in the group I continued with my PhD studies and with my research. As a researcher you have the privilege of working on topics that interest you and the excitement when realising your own design and achieving new results.

What is the "next big thing" in the wireless communication area?
While the millimetre wave band has been successfully used for fixed links, 5G networks, have primarily been deployed in the sub-6 GHz band due to propagation limitations. As we now move to 6G with the ambition of higher data rates utilising the high bandwidths available in the sub-THz band, the challenge is the realisation of chips in these bands, and to provide wireless communication to enable remote monitoring and connectivity of patients and the elderly, radio imaging, and radar technology. Despite the different developments, terrestrial networks still fall short of coverage of remote areas, a challenge that needs to be addressed which became evident during the pandemic.

Considering the innovations in the scientific world in the last 20 years, which was the most remarkable one, which one didn't get the attention it deserved, and which one finished with a "dead end"?
The most remarkable scientific innovation in recent time is the Covid vaccine which saved millions of lives. Innovation not widely known yet are the social robots that were envisaged to become part of everyday life, looking after the elderly and educating children. The Blackberry Storm finished with a dead end due to issues with the SurePress touch screen and Verizon had to replace almost all of the one million Storm smartphones that it sold.

What would like COST INTERACT to achieve?
INTERACT has been supportive of the initiative of Women in Radio Science and offering training courses for young researchers. However, I would have liked to see more gender balance in the leadership.

I'm most passionate about...
Human rights, in particular, for children and women.

What is your country well known for?
Palestine is known for its holy sites for all three main religions. I like the landscape with the sea front on the Mediterranean, the hilly terrain, and the olive trees.

My favourite or personal quote is...
I like the quote from the Monty Python film, Life of Brian 'Always look on the bright side of life'.

INTERVIEW WITH A YOUNG RESEARCHER:
DIEGO DUPLEICH

SENIOR RESEARCHER AT TECHNISCHE UNIVERSITÄT ILMENAU (GERMANY)

Diego Dupleich received the Engineering degree in electronic engineering from Universidad Tecnológica Nacional, Paraná, Argentina, in 2009, the M. Sc. degree in communications and signal processing in 2013, and his doctoral degree in electrical engineering in 2022 from Technische Universität Ilmenau, Germany. He is currently chairing the sub-WG1 on mmWave and (sub-)THz channel sounding and propagation analysis in the COST INTERACT action.

What are your favourite areas of interest and research?
I am interested on propagation and channel modelling.

What was your motivation to become a researcher?
I think there must always be something, on everything I have always loved to get to the bottom of things, to explore and disassemble into smaller pieces and to find the (co-)relation to other things. The father of my grandmother was an astronomist working in an observatory in Chile (my family ended up in Argentina later). Inspired by his passion, I was always curious about radio astronomy. However, I constantly heard "you won't get a job on that", so I had to look for something close, and wireless communications is a field in which we have a lot in common.

What is the "next big thing" in the wireless communication area?
ISAC and its applications in daily life.

Considering the innovations in the scientific world in the last 20 years, which was the most remarkable one, which one didn't get the attention it deserved, and which one finished with a "dead end"?
Everything related to genetics. The latest results on radio astronomy and black holes. Climate change (ironically).

What was your motivation to be part of COST INTERACT?
I was always fascinated by the COST channel model (I think it was the 207) during my studying days and I thought that these people must be something special to come up with such a thing.

How did you became involved in COST INTERACT (or any of the previous Actions)?
My professor always insisted on participating and gave a good advertising about the community, so I joined the IC1004 action.

My favourite book is...
My favourite book is "The Unbearable Lightness of Being" (Milan Kundera).

I'm most passionate about ...
football, music, literature, and gardening.

My favourite or personal quote is ...
"I thought I was the only one, but I am not even one of them".

In few words, I consider myself to be...
a curious introvert (most frustrating combination).

Is there anything else you like to share?
I am worried because we are creating and developing technologies to bring people together. However, instead of creating a big "mass" of humans with common objectives and values for inclusion, equality, respect, and sustainable development, we observe a "clustering" of people with opposite and "orthogonal" ideas. This "polarization" of our society makes me feel lonely.

WG1 - Radio Channels

WG1 had three dedicated sessions on measurements, modeling and ray tracing. There were also two sessions with VT2 on radio channels for vehicular communication, one session with WG2 on performance evaluation, one session with SWG EMF and one with SWG ISAC. The keynote presentation on ITU propagation models presented by R. Rudd was on WG1 invitation. During the discussion session the following topics were discussed: the WG1 white paper which is expected to be finished in July, EuCAP 2024 COST INTERACT Convened Sessions and ETSI ISG THz update. Two workshops were organized at IEEE Meditcom and IEEE Globecom.

WG2 - Signal Processing and Localization & SWG2 ISAC

There were 8 papers presented in WG2 alone, plus another 7 in joint sessions with SWG2 on ISAC and 4 jointly with WG1. Topics among the former group included novel codes, SIC for full duplex communications, effect of PA nonlinearities, interference in IoT networks, NOMA, and waveforms for 6G. Several issues of interest to WG2 also arose in the joint WG1 session (which was mainly related to sub-THz systems): notably the need for a realistic mapping function from SINR to rate, considering also relatively short codes, and also so-called "near-field MIMO". In one of the ISAC sessions a discussion arose about what techniques qualify as ISAC – specifically, how integrated do the communications and sensing need to be?

There was also a discussion session jointly with the ISAC SWG, at which preparations for the White Paper due in June 2024 was discussed mainly. Potential topics across all three areas (physical layer, localisation, and ISAC) were discussed.

WG3 - Network Architectures and Protocols

During this meeting 14 TDs were presented at four sessions. Two sessions were specific for WG3, and two were joint with VT2 and VT4. The coverage of the TDs was extremely broad, ranging from accurate radio channel modelling and accounting in network simulations to network resource management and security; and from the smart city and industry up to satellite communications. Specifically, the use of machine learning for resource management and traffic prediction, jamming and security attacks in 5G and V2X, network optimisations, and new and perspective technologies – e.g., WiFi HaLow, 802.11be and WiFi mesh have been targeted.

VT1 - Health and Well-Being

VT1 held one session during this meeting. 4 TDs were presented and discussed. The TDs covered the following topics: the filtering techniques in gait analysis using depth cameras, an overview of the MedSecurance Project: Advanced Security-for-Safety Assurance for Medical Device IoT (MIoT), a narrowband empirical system loss model for body-to-body networks operating at 2.45 GHz in indoor and outdoor environments, and a new localization approach for in-body nano-machines based on magnetic field.

VT2 - Transportation

VT2 had two shared sessions with WG1, one dealing with channel characterization and novel antenna design and the other with vehicular channel measurements. In the first one, three papers were dealing with channel characteristics, where multi-band channels are investigated. One paper addressed a novel design of a liquid antenna and presented a first prototype. Further, there was a really interesting session where all four papers were discussing measurements in diverse vehicular scenarios. Among other, the papers were dealing with new channel sounder design, accompanying channel measurement data with a deep neural network, signal blockage effect, and cell-free massive MIMO.

VT3 - Industrial Automation

There were three TDs presented covering various focus areas in VT3. First, presented results on the characterization of propagation at (sub-)THz for ISAC in industrial applications. Second, a novel scheduler for URLLC in 5G NR IIoT networks using spatiotemporal traffic correlation was presented. In the last presentation a data-driven approach was used to analyse 5G network latency from theoretical and experimental points of view.

VT4 - Smart Building and Cities

During the joint WG3 and VT4 session 4 TDs were presented. The first one dealt with low-energy effective jamming on 5G network. The second one was a study of band allocation policies in IEEE 802.11be network with devices of different capabilities. The third one was about load-aware channel allocation for Rayleigh fading Wi-Fi HaLow networks. The last one analysed the impact of the two-slope path loss model in the service quality of 4G and 5G small cells. During the discussion slot topics on interoperability between mobile and wireless communications, including cybersecurity/privacy aspects and Wireless Power Transfer and RF energy harvesting, use cases/scenarios and characterization of applications, PHY aspects/RRM/spectrum management/ MAC sub-layers protocols, and system level performance (from sub-6 GHz to millimetre and sub-THz bands).

SELECTED SCIENTIFIC TOPIC:

A WEIGHTED AUTOENCODER-BASED APPROACH TO DOWNLINK NOMA CONSTELLATION DESIGN

End-to-end design of communication systems using deep autoencoders (AEs) is gaining attention due to its flexibility and excellent performance. Besides single-user transmission, AE-based design is recently explored in multi-user setup, e.g., for designing constellations for non-orthogonal multiple access (NOMA). In this paper, the design of AE-based downlink NOMA is further advanced by introducing weighted loss function in the AE training. By changing the weight coefficients, one can flexibly tune the constellation design to balance the error probability of different users, without relying on explicit information about their channel quality. Combined with the SICNet decoder, we demonstrate a significant improvement in achievable levels and flexible control of error probability of different users using the proposed weighted AE-based framework.

Recent trends see shifting the design of encoding and decoding procedures from conventional to machine learning (ML)-based methods. The trend is initiated in the domain of point-to-point communication systems, but has since expanded to multi-user NOMA setup. In this paper there was applied 1) a weighted loss function to control error probability balance across different users, 2) SICNet architecture to enhance deep AE-based decoding capability. Using the proposed weighted AE approach, a significant improvement and flexibility in the error rate performance was obtained, as evidenced by simulation experiments.
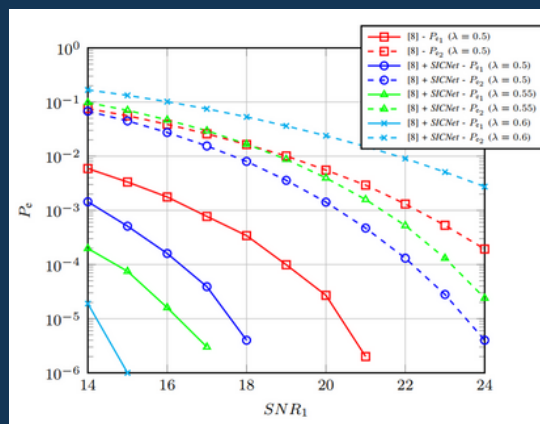
Different architectures (Pe1, Pe2 - error probabilities for different users) versus SNR performance comparison for selected weight factors λ in NOMA downlink transmission with two users.

[8] F. Alberge, "Constellation design with deep learning for downlink non-orthogonal multiple access", PIMRC, 2018

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SELECTED SCIENTIFIC TOPIC:

ENERGY AND PERFORMANCE EFFICIENCY FOR ON-BOARD RADIO RESOURCE MANAGEMENT IN SATELLITE COMMUNICATION SYSTEMS USING NEUROMORPHIC PROCESSORS AND SPIKING NEURAL NETWORKS

One of the main challenges in designing future satellite broadband systems is increasing satellite revenues while meeting uneven and dynamic traffic demands to avoid wasting resources or lack of resources in a multibeam satellite. In this regard, a flexible payload is a promising solution to meet changing traffic demand patterns. As a consequence, recent research interests have focused on designing a new generation of flexible satellite payloads that enable radio resource management (RRM) based on non-uniform traffic demand. This TD proposes an architecture in which the bandwidth, power, and beamwidth assigned to each beam are flexible. In the proposed system, communication resources are managed in response to changes in traffic demand. The proposed architecture is based on training the ML model offline with a training database describing the system behavior. Once the model is trained, the payload controller could be placed onboard the satellite to perform inference. The main advantage of this architecture is that processing times are reduced.

To tackle payload reconfiguration directly on-board of GSO satellites a SNNs trained via supervised learning is proposed. Similarly to the conventional case, the reconfiguration problem is framed as a classification problem, whereby the SNN should select the optimal configuration among a number of pre-selected possible choices.
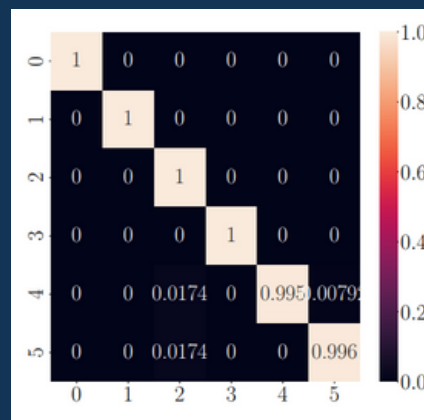
*Confusion matrix for SNN*

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SELECTED SCIENTIFIC TOPIC:

STUDY OF BAND ALLOCATION POLICIES IN IEEE 802.11BE NETWORKS WITH DEVICES OF DIFFERENT CAPABILITIES

The upcoming IEEE 802.11be standard aims to provide extremely high bitrates to support next generation use cases. This amendment is indeed entitled to play a significant role in wireless connectivity in the upcoming years. Among the proposed features, multilink operation (MLO) is indeed the one contributing most towards this goal. MLO enables new types of devices, i.e., multi-link devices (MLDs), to transmit simultaneously over multiple frequency bands (2.4 GHz, 5 GHz and 6 GHz) to achieve massive bitrates (reaching up to 40 Gbps) and, consequently, lower latency. However, the coexistence of MLDs with legacy devices in existing and future wireless local area network (WLAN) deployments has not yet been explicitly investigated. In this work, different band management policies over a three-band densely populated WLAN is investigated, allowing MLDs to use one or more bands for the access procedure and data transfer. The access delay of the devices and the network throughput with respect to the ratio of legacy devices and MLDs is evaluated via extensive simulations. It is shown that by using different band allocation policies for MLDs, several trade-offs regarding throughput and access delay arise that need careful consideration to avoid performance degradation. The potential of appropriately distributing legacy devices across bands is demonstrated, aiming to enhance network balance in terms of access delay per device type, even when comprised of heterogeneous devices.

In the presented figure, the obtained mean access delay performance for MLDs in the four considered cases are shown. A{-} and D{-} indicate which bands are used for channel access and data transfer, respectively.
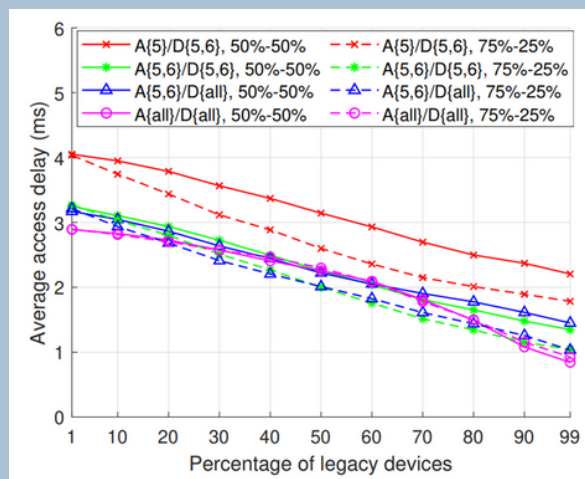
Average delay performance for different channel access and transmission band allocation policies

D. MEDDA, A. IOSSIFIDES, P. CHATZIMISIOS
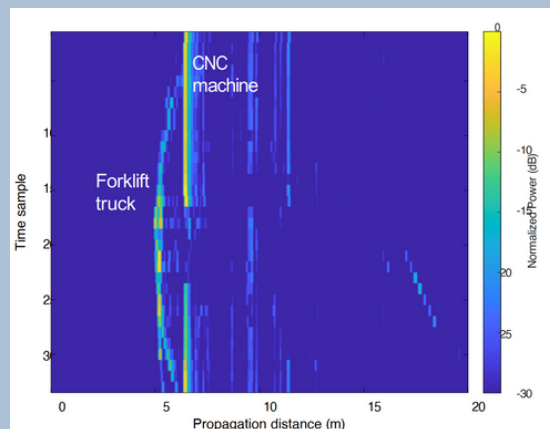**Contact person**
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SELECTED SCIENTIFIC TOPIC:

LATEST RESULTS ON THE CHARACTERIZATION OF PROPAGATION AT (SUB-)THZ FOR ISAC IN INDUSTRIAL APPLICATIONS

The large blocks of instantaneous bandwidth available at (sub-)THz together with the need of the utilization of high gain radio-interfaces makes the (sub-)THz suitable for sensing applications. This paper presents the analysis of novel dual-polarized double directional measurements at 190 GHz in an industrial setting with integrated sensing and communication (ISAC) applications in view. The set-up consists of a bi-static configuration emulating two access points (APs) with beam-steering capabilities in a machine room. One of the APs serves a machine with a wireless link while sensing together with the other AP the environment to detect moving objects. The objective is to detect possible obstructions that could interrupt the communication. The aim of this work was to investigate, from a pure propagation point of view, the properties of (sub-)THz for sensing applications in industrial environments. The results have shown that the system aspects as narrow beams and large bandwidths allow the identification of objects in the environment and this information can be used to predict obstruction of the beams used for communications.

The per-position normalized SO-PDP (synthetic isotropical power delay profile) in the vertical-to-vertical polarization for the different positions of the forklift truck has been displayed in the figure. When the forklift truck is in the middle of the truck, the reflection on the

CNC machine is obstructed, representing the obstruction of communication in a hypothetical case of an external AP to inside of machine case.

Per-position normalized SO-PDP for the different positions of the forklift truck in the scenario

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AVAILABLE GRANTS IN THE INTERACT ACTION

The INTERACT action offers to its members a number of travel grants for secondments and dissemination activities. Following types of grants are available:

1) SHORT TERM SCIENTIFIC MISSIONS (STSMs)

are exchange visits aimed at supporting individual mobility, strengthening existing networks and fostering collaboration between researchers.
There are **up to 5 STSMs** available until October 2023 (2 were awarded in the last month).

2) VISIBILITY BOOSTER (VB) GRANTS

The goal of VBGs is to support activities leading to a strong visibility of the INTERACT COST action, and/or to support initiatives aimed to significantly increase the visibility of the profile of female researchers in the research community and beyond.
There are **2-3 VBs available** until October 2023. Two were already awarded last month.

3) GRANTS FOR ATTENDING CONFERENCES FOR INSTITUTIONS FROM INCLUSIVE TARGET COUNTRIES (ITC)

The aim is to support PhD students and Early Career Investigators (ECI) from INTERACT institutions located in Inclusive Target Countries (ITC) to attend international science and technology-related conferences.
There are **3 ITC grants available** until October 2023.
ALL AWARDED GRANTS MUST BE ACCOMPLISHED UNTIL OCTOBER 2023.
More info available on https://interactca20120.org/

COST INTERACT MACHINE LEARNING CHALLENGE

The Machine Learning Challenge will take place virtually on the **28th of August** and will run for **48 hours**. Two separate challenges will be organized: one for the Physical layer and another for the Network layer. The first challenge (PHY) will focus on direct localization using CSI measurements. The dataset utilized for this challenge is the "Ultra-dense indoor Massive MIMO CSI dataset". The second challenge (NET) will focus on Calibrated PQoS using KPI measurements. The dataset utilized for this challenge is the "Huawei MRC V2I measurement data".

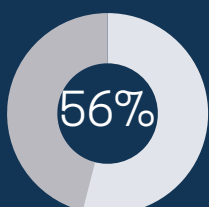The winners of both challenges will be announced at the next meeting in Poznan.

To participate in this event, interested individuals are required to **register by the 21st of August**. via Google form: https://forms.gle/YoeVTdDr3ZvDxMhD8. For further information you may contact the organizer Marco Skocaj marco.skocaj@unibo.it.

We look forward to your enthusiastic participation in the machine learning challenge!
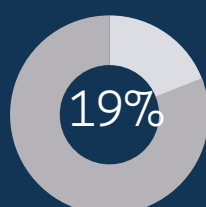
FACTS & FIGURES

Signatory Countries:	47
COST Cooperating Members:	1
COST Partner Members:	1
International Partners:	5
Institutions (University/ Industry/ Research Infrastructures/Enterprises) currently participating:	184

INTERACT Action's Members

551

Participating last meeting

123 99 on site
24 remotely

Young Researchers	Women	Presented TDs in Barcelona	Meetings per year	Training School/Day completed
56%	19%	69	3	3/2