ITUPublications

International Telecommunication Union
Telecommunication Standardization Sector

Crowdsourcing AI and Machine Learning solutions for SDGs

ITU AI/ML Challenges 2024 Report

Disclaimer

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of ITU concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The mention of specific companies or certain manufacturer products does not imply that they are endorsed or recommended by ITU in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

All reasonable precautions have been taken by ITU to verify the information contained in this publication. However, the published material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader.

The opinions, findings and conclusions expressed in this publication do not necessarily reflect the views of ITU or its membership.

ISBN

978-92-61-39451-6 (Electronic version)
978-92-61-39461-5 (EPUB version)
978-92-61-39471-4 (Mobi version)

Please consider the environment before printing this report.

Crowdsourcing AI and Machine Learning solutions for SDGs

ITU AI/ML Challenges 2024 Report

Foreword

The ITU Artificial Intelligence and Machine Learning (AI/ML) Challenges are competitions where anyone can participate to solve problem statements to advance the achievement of Sustainable Development Goals (SDGs) using AI/ML. The competitions enable participants to connect with new partners – and new tools and data resources – to achieve goals set out by problem statements contributed by industry and academia.

I am pleased to say that these competitions have welcomed over 8,000 participants since their launch in 2020.

The competitions stimulate global access to AI/ML expertise and capabilities and empower participants to create, train, and deploy ML models by offering curated problem statements, data, technical webinars, mentoring, and hands-on training sessions. This enhances participants' skills and global recognition and also supports a more inclusive ITU standardization process by paving the way for participants to make valuable contributions to ITU's specifications.

More than 70 percent of the participants in 2023 were students, with a large majority from the African region.

To share the outcomes with the larger community, solutions submitted are shared as open source in several repositories on the Challenge GitHub: https://github.com/ITU-AI-ML-in-5G-Challenge.

This report highlights the important work of teams across the globe. It features winning solutions that are the result of innovative approaches to solving problems with applications of AI across several domains.

Seizo Onoe
Director
ITU Telecommunication Standardization Bureau

Table of contents

List of figures and tables

Figures

Tables

Acronyms

ACM	Association for Computing Machinery
AI	Artificial Intelligence
CSV	Comma-separated Value
FG AN	Focus Group Autonomous Networks
GNN	Graph Neural Networks
IEEE	Institute of Electrical and Electronics Engineers
IPR	Intellectual Property Rights
ITU J-FET	International Telecommunication Union Journal on Future and Evolving Technologies
ML	Machine Learning
NDA	Non-disclosure Agreement
PoC	Proof of Concept
RRM	Radio Resource Management
SDG	Sustainable Development Goal
SG	Study Group
TSB	Telecommunication Standardization Bureau

1 Executive Summary

Artificial Intelligence (AI) is a dominant technology and impacts every aspect of society. As AI continues to evolve, AI/ML-enabled applications and services integrated with the future of communication networks would drive innovation and related standards. ITU is at the forefront of exploring how best to apply AI/ML through various initiatives and projects to advance the achievement of sustainable development goals (SDGs). ITU AI/ML competitions, bring together AI/ML stakeholders to brainstorm, innovate and solve relevant problems in telecommunication networks, Geospatial challenges, tinyML use cases, etc. Building on its standards community, ITU has been conducting global ITU AI/ML Challenges mapped to several areas impacting SDGs.

The **ITU AI/ML in 5G Challenge** aims to solve real-world communication network problems using AI and ML, focusing on the development and optimization of 5G and emerging 6G technologies. Participants engage in technical webinars, mentoring, and hands-on sessions, creating and deploying ML models, and applying ITU standards, thereby gaining global recognition for their innovative solutions.

The **GeoAI Challenge** applies AI/ML to address real-world geospatial problems related to the UN SDGs. Participants gain practical experience by tackling issues such as environmental monitoring, urban planning, and disaster response, promoting innovative solutions for sustainable development, and offering prizes, recognition, and certificates to top performers.

The **tinyML Challenge** explores applying machine learning to tiny devices and embedded systems to build cost-effective, low-power, reliable, and easy-to-install, solutions by leveraging tinyML technology.

The ITU AI/ML Challenge offers carefully curated problem statements, a mix of real-world and simulated data, technical webinars, mentoring, and hands-on sessions. Teams participating in the Challenge enable, create, train, and deploy ML models for different domains. This enables participants to not only showcase their talent, test their concepts on real data and real-world problems, and compete for global recognition including prize money and certificates, but also enter the world of ITU standards by mapping their solutions to our specifications.

The ITU AI/ML Challenge has had profound impacts across multiple dimensions.

Standards: The challenge has facilitated the integration of innovative AI/ML solutions into ITU specifications, ensuring new technologies are standardized and widely adopted.

Research: The challenge has spurred cutting-edge investigations and practical applications, leading to numerous publications in journals and conferences.

Community building: The challenge has also fostered a vibrant community of AI/ML practitioners, with members from diverse backgrounds and over 100 countries, creating a global network of collaborators and innovators.

Capacity building: The challenge has provided participants with invaluable skills through technical webinars, hands-on workshops, and mentoring sessions, enhancing their ability to tackle real-world problems.

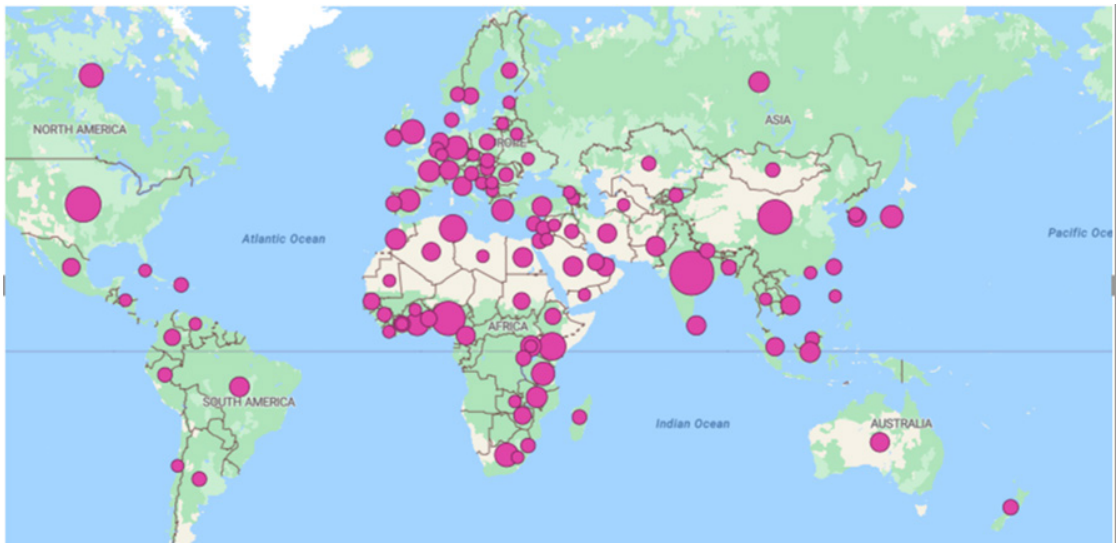
Overall, the ITU AI/ML Challenge has significantly contributed to technological advancement, global collaboration, and the development of a robust ecosystem that drives progress in AI/ML and communication networks.

2 Introduction

The ITU AI/ML Challenge was launched in 2020. The first edition ran on the theme "*How to apply ITU's ML architecture in 5G networks*" and applied to the communication networks domain (ITU AI/ML in 5G Challenge). ITU is at the forefront of leveraging AI/ML to achieve SDGs. Through a variety of activities and projects, ITU brings together multiple stakeholders to brainstorm, innovate, and solve relevant problems across different domains. The ITU AI/ML Challenge is one of the key initiatives aimed at fostering global collaboration and innovation in the application of AI/ML to SDGs with an emphasis on communication networks. This challenge has been instrumental in exploring how AI can be applied to 5G, geospatial technologies, tinyML, and other areas to drive progress towards the SDGs.

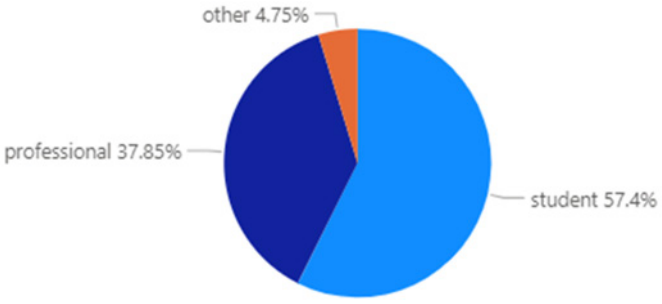
ITU is at the forefront of leveraging AI/ML to achieve sustainable development goals. Through a variety of activities and projects, ITU brings together multiple stakeholders to brainstorm, innovate, and solve relevant problems across different domains especially in the AI and Machine Learning domains to advance SDGS.

Figure 1: Geographic distribution of participants by country/region from 2020 - 2023



The boundaries and names shown, and the designations used on this map do not imply official endorsement or acceptance by the United Nations/ITU.
Note: participants from more than 100 countries/regions participated in the Challenge. The top four countries are as follows: India, United States, China and Nigeria.

Figure 2: Distribution of participants for the challenge



Note: more than 57% of participants are professionals and around 38% are students.

Since 2020, the ITU AI/ML Challenge has evolved to include multiple domains, each addressing specific areas of interest and impact. The challenge connects participants from over 100 countries, including students, professionals, industry experts, and academia, to solve real-world problems using AI/ML. The competitions offer carefully curated problem statements, a mix of real-world and simulated data, technical webinars, mentoring, and hands-on sessions. Participants create, train, and deploy ML models, enabling them to showcase their talent, test their concepts on real data, and compete for global recognition, including prize money and certificates. This initiative also provides a gateway to the world of ITU standards, as participants map their solutions to ITU specifications.

The domains covered in the ITU AI/ML Challenge include AI/ML in 5G and 6G (or communication networks), GeoAI, tinyML, AI for Climate Action, and Fusion. Each domain offers unique opportunities for participants to apply their skills and gain hands-on experience in addressing critical issues. The AI/ML in 5G Challenge focuses on the application of AI/ML in communication networks, optimizing the development and performance of 5G and 6G technologies. The GeoAI Challenge addresses geospatial problems related to the UN SDGs. The tinyML Challenge explores the application of ML in tiny devices and embedded systems. The AI for Climate Action Innovation Factory aims to develop AI solutions for combating climate change, while the Fusion Challenge focuses on using ML for predictive modeling in fusion energy systems. Through these diverse domains, the ITU AI/ML Challenge continues to drive innovation and collaboration, contributing to the advancement of global standards and the development of impactful solutions.

Figure 3: Various domains covered in the ITU AI/ML Challenge

The 2023 ITU AI/ML Challenge saw more than 3300 participants from 100+ countries in the challenge. These participants contributed over 20'000 submissions and received 56'267 CHF in prize money from ITU and sponsors. Detailed statistics of the challenge can be found in section 4.2.

ITU is at the forefront of leveraging AI/ML to achieve sustainable development goals. Through a variety of activities and projects, ITU brings together multiple stakeholders to brainstorm, innovate, and solve relevant problems across different domains especially in the AI and Machine Learning domains to advance SDGS.

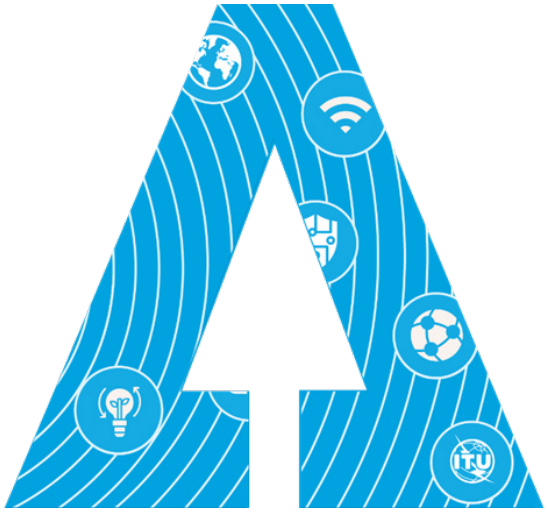
3 Domains and Areas of Competition

Since 2020, the ITU AI/ML Challenge has evolved to include multiple domains, each addressing specific areas of interest and impact. These competitions are run annually, with each edition introducing new themes and expanding the scope of the challenge. The competitions have included AI/ML in 5G and 6G (i.e. communication networks), GeoAI, tinyML, AI for Climate Action, and Fusion. Each domain offers unique opportunities for participants to apply their skills, gain hands-on experience, and contribute to solving pressing global issues.

3.1 AI/ML in 5G and 6G (Communication Networks)

Applying machine learning in communication networks

The ITU AI/ML in 5G Challenge rallies like-minded students and professionals from around the globe to solve real-world problems in communication networks by applying AI and machine learning (ML). The AI/ML in 5G Challenge, launched as the first edition in 2020, has become a cornerstone of the ITU AI/ML Challenge. This competition focuses on applying AI/ML in communication networks, particularly in the development and optimization of 5G and emerging 6G technologies. As telecommunication networks evolve towards 6G, AI is expected to be integral to the network's design, enabling advanced features like AI-native infrastructure, pervasive intelligence, and real-time responsiveness.



ITU AI/ML in 5G Challenge analyses practical problems in networks using real and simulated data. As we aim for enhanced efficiency, reliability, and rich user experience using AI/ML in communication networks, ITU calls for the application of its pre-standard and standard concepts in network management, security, optimization, and beyond to solve real-world problems. In the ITU AI/ML in 5G Challenge, participants from various backgrounds collaborate to solve real-world problems using AI/ML, working on curated problem statements with access to a mix of real-world and simulated data. The challenge includes technical webinars, mentoring, and hands-on sessions, enabling participants to create, train, and deploy ML models for communication networks. The competition not only showcases talent and innovative solutions but also provides a pathway for participants to engage with ITU standards and gain global recognition.

3.2 Geospatial Artificial Intelligence

Applying Machine Learning to Geospatial Analysis

The Geospatial Artificial Intelligence Challenge (GeoAI), now entering its third edition in 2024, addresses real-world geospatial problems by applying AI/ML. This competition aims to solve issues related to the UN SDGs using real-world data. Participants gain practical experience in applying AI/ML to geospatial data, tackling problems such as environmental monitoring, urban planning, and disaster response. The challenge promotes innovative solutions that contribute to sustainable development, offering prizes, recognition, and certificates to the top performers.

3.3 tinyML

Applying Machine Learning to Edge Devices

The tinyML Challenge, organized in collaboration with industry partners, explores the application of machine learning in the domain of tiny devices and embedded systems. The second edition of this challenge in 2023 focused on developing a Next-Gen tinyML Smart Weather Station that is cost-effective, low-power, reliable, and easy to install and maintain. This weather station will measure various weather conditions, particularly rain and wind, using tinyML technology. Additionally, the tinyML Challenge includes projects on scalable and high-performance solutions for crop disease detection and wildlife monitoring. This competition encourages innovation in environmental monitoring and agriculture, leveraging the capabilities of tinyML.

3.4 AI for Climate Action

An accelerator platform for AI-powered climate change solutions from start-ups

Climate change is a significant global challenge with far-reaching impacts. The AI for Climate Action Innovation Factory, launched at the AI for Good Summit in 2024, seeks to advance the use of AI in combating climate change. This initiative builds on previous successes and focuses on developing AI solutions that address climate-related issues. The 2024 edition aims to showcase these solutions at COP29, the United Nations Climate Change Conference in Baku, Azerbaijan. The winners of this competition will be recognized for their contributions to the Green Digital Action track, highlighting the role of AI in promoting sustainable practices and mitigating climate change.

The AI for Climate Action seeks to advance the use of AI in combating climate change. Solutions submitted to this competition highlights the role of AI in promoting sustainable practices and mitigating climate change.

3.5 Fusion Energy

The Fusion Challenge, part of the IAEA Coordinated Research Project on AI for Fusion, explores the potential of ML in predictive modeling for fusion energy systems. Fusion energy, generated by combining light elements to form a heavier one, represents a promising alternative energy source. This challenge engages the scientific community in developing cross-machine disruption prediction models using ML, utilizing data from fusion devices such as Alcator C-Mod, J-TEXT, and HL-2A. Participants gain hands-on experience in AI/ML applications relevant to fusion energy science, competing for prizes, recognition, and certificates. This competition supports the global effort to make fusion a commercially viable energy source.

The ITU AI/ML Challenge, through its diverse domains and competitions, continues to drive innovation and collaboration in AI/ML. By addressing critical issues across various sectors, the challenge contributes to the advancement of global standards and the development of solutions that have a significant impact on society.

4 Participation

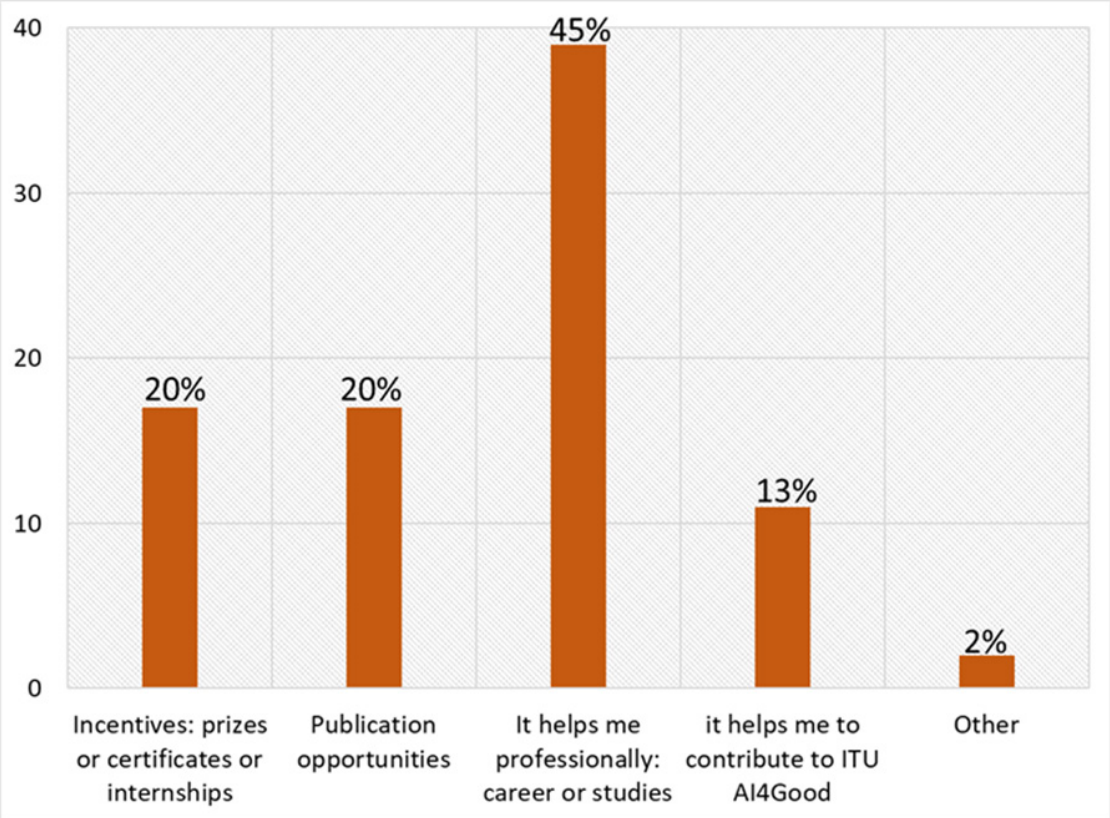
Participation is open to ITU members and any individual from an ITU Member State. "Participants" are individuals or companies that participate in the ITU AI/ML in 5G Challenge, providing solutions to problem sets of the Challenge.

There are two categories of participants: student and professional.

4.1 Motivation to Participate

After each iteration of the challenge is completed, participants are asked to complete a survey prepared by the challenge secretariat. One of the key questions in the survey focuses on the participants' motivation for joining the challenge. The figure below illustrates the various reasons why individuals choose to participate in the ITU AI/ML Challenges. Notably, the primary motivation for most participants is the opportunity to upskill or enhance their professional or academic capabilities, rather than the pursuit of prizes.

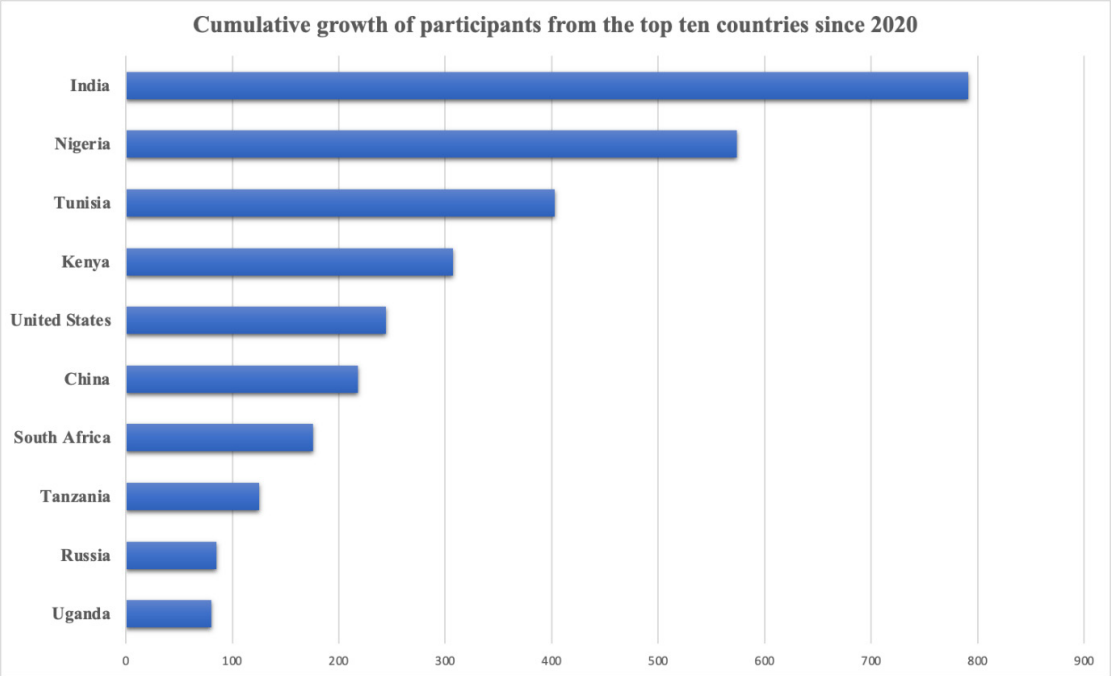
Figure 4: Motivation to participate in the challenge



4.2 Statistics

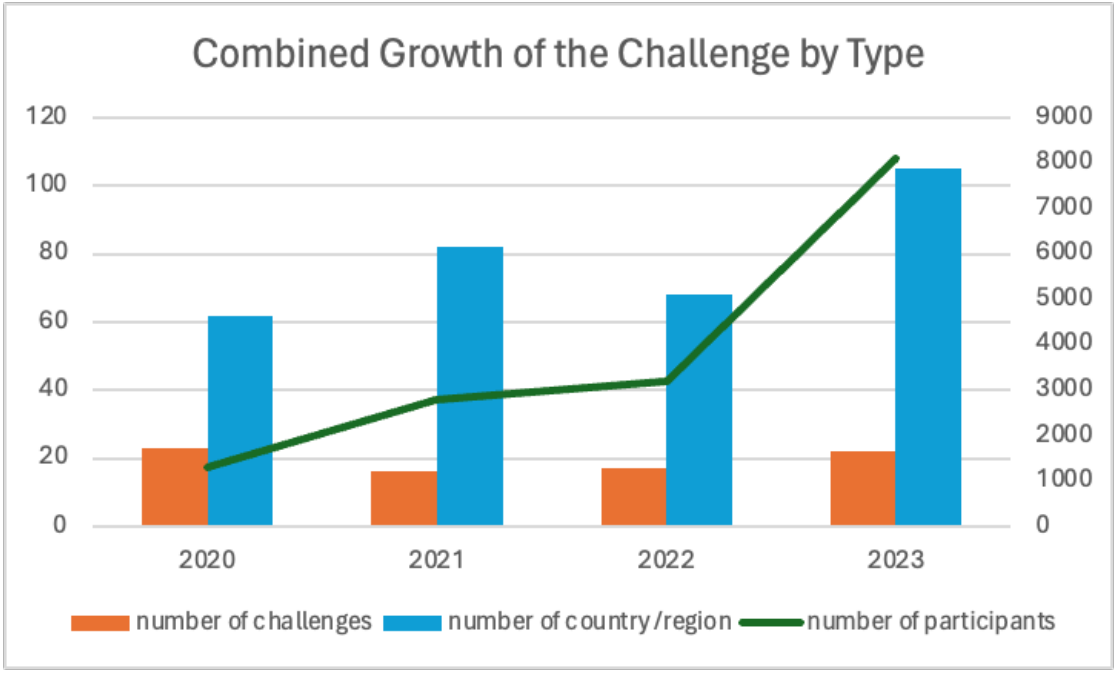
ITU's machine learning challenges have seen an exponential increase in participation since 2020, welcoming over 8,000 participants from more than 100 countries, with developing countries particularly well represented, as the chart below demonstrates.

Figure 5: Cumulative growth of participants from the top ten countries since 2020



The number of participants has increased four times since 2020 reaching around 8000 in the year 2023. See the graph below:

Figure 6: Combined Growth of the Challenge by Type



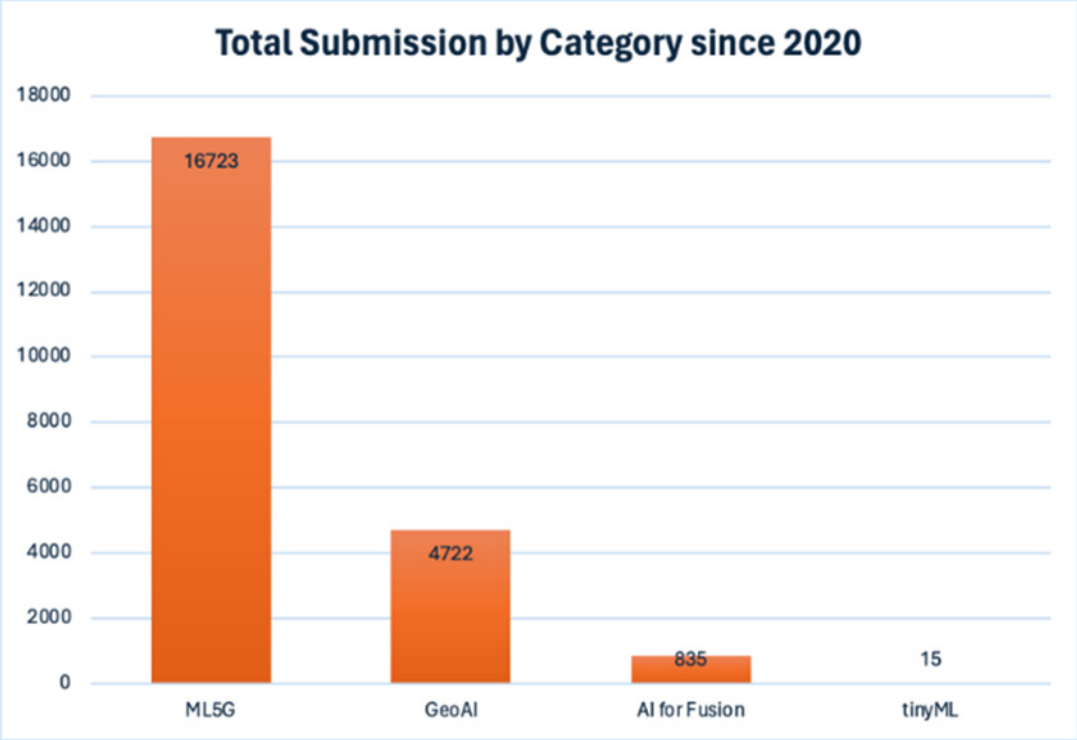
Participants in the challenge have made more than 23'000 submissions to the challenge by June of 2024. The below tables show granular participation details to some problem statements of the ITU AI/ML Challenge problem statements in 2023. Most of these problem statements were hosted through the Zindi platform.

Table 1: Competition Details

Competition Name	Enrolled	Submitted	Female Participation	Submissions	Number of hours worked	Prize Money
Fault Impact Analysis: Towards Service-Oriented Network Operation & Maintenance	232	94	12.9%	4178	12534	$8,800
Network Traffic Scenario Prediction Challenge	350	118	10.3%	1220	3660	$1,000
GEO-AI Challenge for Cropland Mapping	326	75	9.5%	2264	6792	$4,000
GEO-AI Challenge for Landslide Susceptibility Mapping	196	20	17.3%	309	927	$1,000
QoS Prediction Challenge	231	139	19.0%	2601	7803	-
Title Extraction in Lecture Slides Challenge	154	27	**35.1%**	515	1545	-
Next-Gen WiFi Throughput Prediction Challenge	201	58	14.4%	552	1656	$1,000
GeoAI Challenge Location Mention Recognition from Social Media	138	29	5.8%	549	1647	$1,100
GeoAI Challenge for Air Pollution Susceptibility Mapping	206	37	10.7%	225	675	$1,000
AI/ML for 5G-Energy Consumption Modelling	**773**	**224**	9.8%	**7852**	**23556**	**$22,000**
Multi-Machine Disruption Prediction Challenge for Fusion Energy	320	30	7.8%	291	873	$5,000
GeoAI Challenge Estimating Soil Parameters from Hyperspectral Images	166	35	10.8%	612	1836	$1,000
Total Cumulative	**3293 (1905)**	**886 (552)**	**13.6%**	**21168**	**63504**	**$46,000**

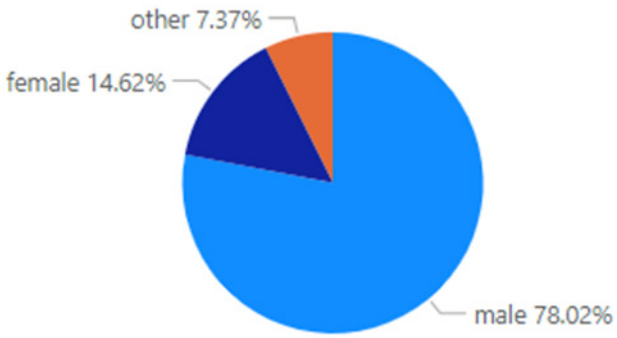
Competition Name	Countries	Countries in Africa	Developing countries	Users in developing countries
Fault Impact Analysis: Towards Service-Oriented Network Operation & Maintenance	47	22	37	188
Network Traffic Scenario Prediction Challenge	59	24	48	291
GEO-AI Challenge for Cropland Mapping	60	23	46	254
GEO-AI Challenge for Landslide Susceptibility Mapping	46	20	35	154
QoS Prediction Challenge	36	23	29	208
Title Extraction in Lecture Slides Challenge	33	19	24	133
Next-Gen WiFi Throughput Prediction Challenge	35	21	32	165
GeoAI Challenge Location Mention Recognition from Social Media	35	21	33	115
GeoAI Challenge for Air Pollution Susceptibility Mapping	45	20	34	164
AI/ML for 5G-Energy Consumption Modelling	**83**	**30**	**60**	**592**
Multi-Machine Disruption Prediction Challenge for Fusion Energy	53	24	38	241
GeoAI Challenge Estimating Soil Parameters from Hyperspectral Images	40	19	30	116
Total	**99**	**31**	**72**	**2621 (1288)**

Figure 7: Participation and total # submissions for 2023 in various domains of the ITU AI/ML Challenges



The gender distribution graph reveals that nearly 80% of the participants are male, highlighting the importance of encouraging greater female participation.

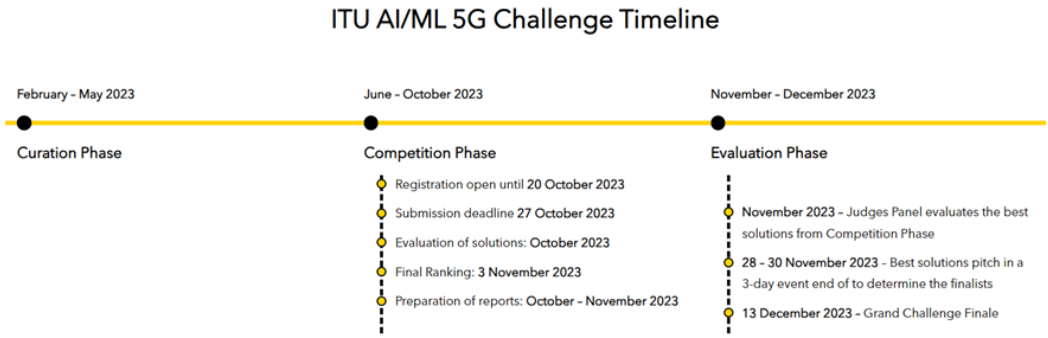
Figure 8: Participants Gender Distribution



4.3 Challenge Phases/Timeline

The ITU AI/ML Challenge is run throughout the year depending on problem statements provided by partners. An example of a challenge timeline for the 2023 ITU AI/ML in 5G Challenge is illustrated below to show the various phases of the challenge.

Figure 9: 2023 ITU AI/ML Challenge Timeline

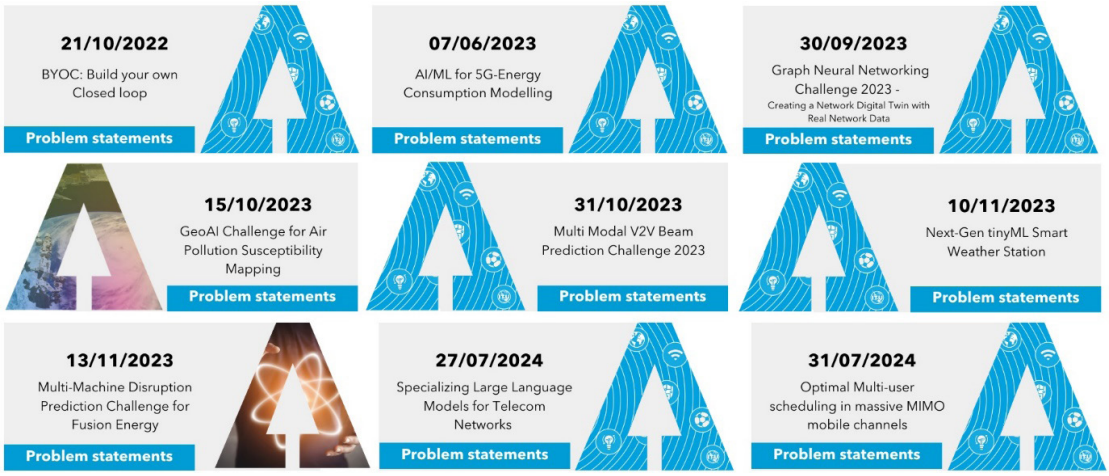


5 Problem statements

Participants of the ITU AI/ML Challenge can solve real-world problems (including those with social relevance). Problem statements are contributed either from ITU's standards and specifications, or from hosts of problem statements who are institutions interested in advancing SDGs or can be decided by the participant(s) themselves. Problem statements will fall into a specific challenge domain based on the problem owner (host) interest and resources.

The AI for Good Global Summit identifies practical applications of AI/ML with the potential to accelerate progress towards the United Nations Sustainable Development Goals. Solutions are invited in fields such as education, healthcare and wellbeing, social and economic equality, climate action, natural disaster management, space, and smart and safe mobility. Selected teams will be invited to participate in the AI for Good Summit.

Figure 10: Sample Challenge problem statements



The ITU AI/ML Challenge continues to host problem statements from hosts around the world. Some of the scheduled problem statements are as follows:

- Green Telecom: Smart Energy Supply Scheduling [Smart energy supply scheduling for both carbon footprint reduction and network reliability guarantee]
- Beam-level Traffic Prediction
- Specializing Large Language Models for Telecom Networks
- Ground-level NO2 Estimation Challenge
- Radio Resource Management (RRM) for 6G in-X Subnetworks

The ITU AI/ML Challenge serves as a crucial bridge between current innovations and future research and standards. By engaging participants in solving real-world problems using AI and ML, the challenge fosters the development of practical solutions that can inform future research directions. These solutions often lead to new insights and discoveries, fuelling further investigations and academic studies.

The ITU AI/ML Challenge serves as a crucial bridge between current innovations and future research and standards. Challenge solutions leads to new insights and discoveries, fueling further investigations and standards contributions.

Moreover, the challenge encourages the application of ITU's pre-standard and standard concepts in areas such as network management, security, and optimization. Participants map their solutions to ITU specifications, which not only validates the practicality of these standards but also provides valuable feedback for their evolution. This iterative process helps to refine and enhance existing standards, ensuring they remain relevant and effective as technologies advance.

Additionally, the collaborative environment of the challenge brings together a diverse group of stakeholders, including researchers, industry professionals, and policymakers. This convergence facilitates the exchange of ideas and best practices, promoting a unified approach to addressing emerging technological challenges. As a result, the ITU AI/ML Challenge not only contributes to the current body of knowledge but also lays the groundwork for the development of future research and the establishment of robust, globally recognized standards.

The problem statements hosted by the ITU AI/ML Challenge since 2020 can be found on the link here: https://github.com/ITU-AI-ML-in-5G-Challenge/AI-ML-in-5G-Challenge.github.io

6 Winning solutions

Since its inception in 2020, the ITU AI/ML Challenge has awarded prizes to over 300 participants across various competitions. In this section, we highlight some of the remarkable solutions submitted to the ITU AI/ML Challenge.

Photo 1: *Representative winners of 2023 ITU AI/ML Challenge presenting their experience during the 2024 AI for Good workshops*

6.1 AI/ML for 5G-Energy Consumption Modelling

The aim of this challenge was to reduce the energy consumption of 5G base stations using AI/ML. The winning solution, which was featured and showcased at COP28 in Dubai, utilized artificial neural networks combined with other techniques to achieve up to a 20% reduction in energy consumption. This competition attracted over 1000 participants and received more than 12,246 submissions from 83 countries, demonstrating the global interest and innovation in optimizing energy use in 5G networks.

The Challenge was hosted on both the ITU platform (link here: https://challenge.aiforgood.itu.int/match/matchitem/83) and the Zindi platform (link here: https://zindi.africa/competitions/aiml-for-5g-energy-consumption-modelling)

Figure 11: Winner announcement of AI/ML for 5G-Energy Consumption Modelling challenge at COP28 in Dubai

6.2 Build-a-thon

The build-a-thon is a problem statement in ITU AI/ML in the 5G Challenge hosted by ITU-T Focus Group Autonomous Networks (FG AN). It aims to demonstrate and validate important use cases for autonomous networks, creating proof of concept implementations and tools in the process. As an open platform, FG AN is well-poised to enable access to experts, students, and industry, collaborate with other external events such as plugfests and hackathons, and set the stage for collaboration in open-source projects, other proof of concept (PoC) and standardization work.

In essence, a build-a-thon is a common, open platform for like-minded people to come together (remotely) and build something to prove a point. In the case of FG AN, it is defined as below:

1 Build-a-thon is a PoC development activity, to build upon a key concept in FG AN, especially intended to prove the concept practically with code, test setup, and demo setup.
2 Build-a-thon is not intended to create a product, nor would the code created as part of Build-a-thon be considered as product quality software.
3 Build-a-thon would create well-documented artifacts and open-source code.

Winning solutions were showcased during build-a-thon workshops, and some contributions were integrated into the development of FG-AN deliverables. These deliverables formed the basis of SG13 recommendations and technical reports on autonomous networks, such as Y.3061.

The build-a-thon problem statements: https://challenge.aiforgood.itu.int/match/matchitem/68

The Proof-of-concept report by FG AN summarizes the achievements of the build-a-thon activities: https://www.itu.int/en/ITU-T/focusgroups/an/Documents/PoC_activities.pdf

6.3 Graph Neural Networks (GNN)

The Graph Neural Networks challenge, organized from 2020 to 2023, focused on leveraging GNN for various applications within communication networks and beyond. Participants developed innovative solutions using GNN techniques, contributing to the advancement of this cutting-edge field. The challenge provided a platform for exploring the potential of GNN in improving network performance and other complex tasks.

Description and details of different editions of the Graph Neural Networks challenge can be found here: https://bnn.upc.edu/challenge/

Workshops: https://bnn.upc.edu/workshops/gnnet2024/

Paper: *The Graph Neural Networking Challenge: AWorldwide Competition for Education in AI/ML for Networks*: https://dl.acm.org/doi/10.1145/3477482.3477485

Figure 12: 2nd GNNet Workshop

6.4 Smart Weather Station

This challenge aimed to develop a low-cost, low-power, smart weather station with no moving parts based on tinyML. The team from CSEM developed "Aurora," a prototype that meets these criteria and is currently undergoing further improvements. Aurora represents a significant step forward in weather monitoring technology, providing reliable data collection while minimizing maintenance and operational costs.

Figure 13: Aurora smart weather station

The ITU AI/ML Challenge continues to inspire innovative solutions that address real-world problems. By showcasing these winning solutions, the challenge not only rewards the ingenuity of participants but also contributes to the broader goals of technological advancement and sustainable development.

7 Incentives

7.1 Prizes

Since 2020, the ITU AI/ML Challenges have provided numerous incentives to participants and hosts of problem statements, fostering innovation and collaboration in AI/ML. Through generous sponsorships, the challenges have disbursed over 127,731 CHF in prize money to the winners of various competitions. This financial reward recognizes and encourages the development of cutting-edge solutions to complex problems.

7.2 Certificates

In addition to monetary prizes, participants have received certificates acknowledging their contributions and participation in the challenges. These certificates not only serve as a formal recognition of their efforts but also enhance their professional credentials, opening up further opportunities in the field of AI/ML. Through these incentives, the ITU AI/ML Challenges continue to attract talented individuals and teams from around the world, driving progress and excellence in the application of AI/ML technologies. The top three teams selected will be recognized and certificates of appreciation shall be presented below:

- 1st prize winning team: "Gold"
- 2nd prize winning team: "Silver"
- 3rd prize winning team: "Bronze"

Additional prizes and letters of appreciation may be awarded on a per-topic basis at the discretion of the judges during the event.

Furthermore, hosts of problem statements have offered additional incentives to participants. For instance, TTC in Japan has awarded monetary prizes and trophies to recognize exceptional contributions. The GNN challenge has provided winners the opportunity to present their work at prestigious conferences, giving them a platform to showcase their innovations to a broader audience.

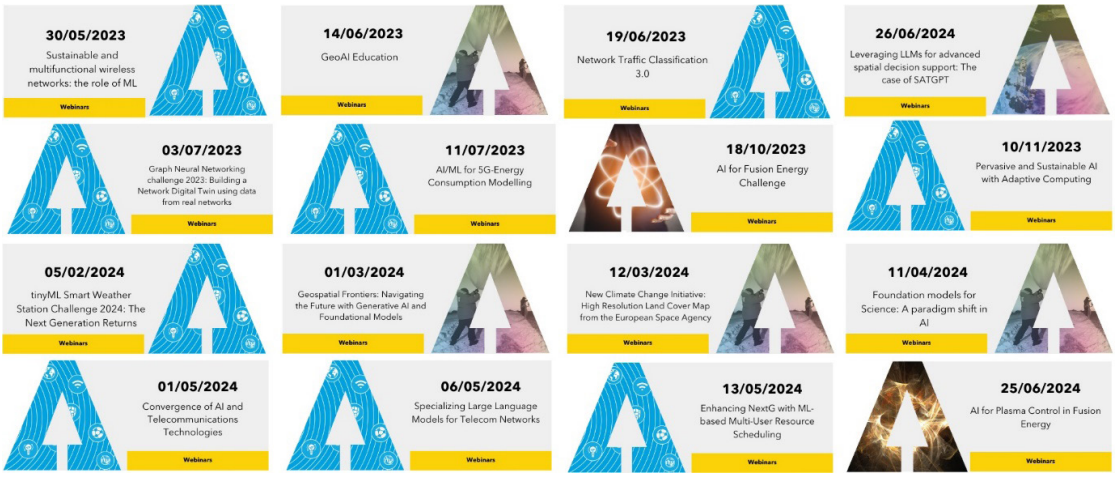
Figure 14: Winner Certificates

8 Webinars

In collaboration with 47 United Nations organizations, the ITU organizes "AI for Good," the premier UN event series, content hub, and networking platform dedicated to leveraging artificial intelligence to achieve the United Nations SDGs. AI for Good features nearly daily in-depth technical sessions covering a broad range of AI applications, including AI + Climate Science, AI + Health, GeoAI, AI + Earth and Sustainability Sciences, Trustworthy AI, AI + Manufacturing, AI + Communication Networks, AI + Robotics, AI + Biodiversity, and AI + Finance.

The platform supports a thriving community of over 35,000 AI experts, collectively known as the "Neural Network," which continues to grow. Through AI for Good, experts have organized webinars to provide detailed explanations of various problem statements. Additionally, mentoring sessions and round-table discussions have been arranged to complement these webinars, offering participants comprehensive support and insights into applying AI to solve global challenges.

Figure 15: The ML5G webinar series in 2020



9 Capacity building

The ITU AI/ML Challenges are not only competitions, but also comprehensive capacity-building initiatives aimed at enhancing the skills and knowledge of participants in the field of artificial intelligence and machine learning. These activities are designed to provide participants with the tools, resources, and mentorship needed to tackle complex real-world problems effectively. Here are some key capacity-building activities conducted under the ITU AI/ML Challenges:

The ITU AI/ML Challenge is used as a capacity-building initiative aimed at enhancing the skills and knowledge of participants in the field of artificial intelligence and machine learning.

9.1 Technical Webinars

Experts in AI/ML and related fields conduct webinars to provide in-depth knowledge on various topics relevant to the challenges. These sessions cover fundamental concepts, advanced techniques, and specific applications of AI/ML in different domains. Participants gain valuable insights and stay updated with the latest developments in the field.

9.2 Hands-On Workshops

Workshops are organized to give participants practical experience in developing AI/ML models. These hands-on sessions guide participants through the process of creating, training, and deploying machine learning models. By working on real-world datasets and problem statements, participants can apply theoretical knowledge to practical scenarios.

9.3 Mentoring Sessions

One of the core components of the ITU AI/ML Challenges is the mentoring provided to participants. Experienced mentors from industry and academia offer guidance on various aspects of the challenges, including problem-solving approaches, technical issues, and project management. This personalized support helps participants refine their solutions and enhance their understanding. As of July 2024, the ITU AI/ML Challenge mentoring activities are on-going in the following countries: Nigeria, Zimbabwe, Zambia, Tanzania, and Ethiopia.

9.4 Round-Table Discussions

Round-table discussions bring together participants, experts, and stakeholders to discuss challenges, share experiences, and exchange ideas. These sessions foster a collaborative environment where participants can learn from each other and gain diverse perspectives on AI/ML applications and methodologies. These sessions also provide a platform for challenge participants to clarify issues with challenge hosts as it provides a platform for exchange between participants and problem statement owners.

9.5 Online Learning Resources

Participants have access to a wealth of online learning resources, including tutorials, research papers, and technical documentation. These resources are curated to help participants build a strong foundation in AI/ML and stay informed about cutting-edge technologies and techniques.

9.6 Certification and Recognition

Participants receive certificates acknowledging their participation and contributions to the challenges. These certificates serve as formal recognition of their efforts and achievements, enhancing their professional credentials and opening up further opportunities in the field of AI/ML.

Through these capacity-building activities, the ITU AI/ML Challenges empower participants with the knowledge and skills needed to develop innovative solutions and contribute to the advancement of AI/ML technologies globally. By fostering a supportive and collaborative learning environment, ITU ensures that participants are well-prepared to tackle the complex challenges of today and the future.

10 Intellectual property rights

The intellectual property rights (IPR) are determined by the submitter. The declarations by the submitter would be stored by ITU and made available online.

Intellectual Property related to the submissions:

- Participants should do due diligence on the intellectual property related to the submissions. E.g. if the participant considers it necessary to secure IP before submissions, via a patent application, she should do so before submitting the solution to the challenge.
- In terms of transparency, being an open competition, if a participant wins the challenge, they will need to have a publicly available version of their solution.

11 Challenge Solution Contributions

11.1 Standards

ITU has developed a range of standards-based Machine Learning mechanisms in 5G. The goal is to provide a full toolkit to build Machine Learning into networks. Participants of the ITU AI/ML Challenge, especially communication networks, are encouraged to base their work on ITU standards.

Through the challenge engagements, participants were able to make contributions and submissions that were used by the FG-ML5G and FG-AN to improve deliverables that were under development as part of pre-standardization activities. These focus group deliverables have now turned into ITU recommendations. Examples include the Y.3172 series as an example of the link between standards and community and mentoring as well as Y.3061 as an example of the link between open source, build-a-thon, and community and mentoring.

11.2 Open Source

The Challenge encourages the submission of open-source implementations, based on ITU standards. Open-source implementations will enable a broad range of stakeholders to access the outcomes of the Challenge and continue collaborating with relevant Challenge participants. Participants are encouraged to submit on the challenge GitHub code, report, slides, demos, publications, and any other supporting materials.

The Challenge encourages the submission of open-source implementations, and participants are encouraged to submit on the challenge Github code, report, slides, demos, publications, and any other supporting materials.

The following are links to various GitHub repos of the ITU AI/ML Challenge

- AI/ML in 5G Challenge & tinyML: https://github.com/ITU-AI-ML-in-5G-Challenge
- GeoAI: https://github.com/ITU-GeoAI-Challenge
- Fusion Energy: https://github.com/AI-for-Fusion-Energy

However, solutions based on proprietary implementations are also accepted.

11.3 Journal and Conference Publications

The ITU AI/ML Challenge has facilitated the publication of numerous solutions in journals and conferences, contributing to the body of knowledge in the field of artificial intelligence and machine learning. Participants' work has been recognized and disseminated through platforms such as the ITU Journal on Future and Evolving Technologies (ITU J-FET), IEEE journals, and ACM conferences. Below is an overview of the publication activities and special issues dedicated to AI and ML for communication networks.

As of December 2023, thirty-six (36) papers have been published by ITU J-FET and the fourth special edition of the journal is going through the review process. The call for papers of the ITU J-FET is included in Figure 16 below.

Figure 16: The call for paper for the special issue of the peer-reviewed ITU Journal for Future and Evolving Technologies

11.3.1 ITU Journal on Future and Evolving Technologies

The best peer-reviewed papers resulting from the Challenge are featured in a special issue of the ITU Journal "Future and evolving technologies" (https://www.itu.int/en/journal/j-fet/). The ITU J-FET has published several special issues featuring outstanding solutions from the ITU AI/ML Challenge. These special issues focus on various aspects of AI and machine learning in communication networks, showcasing innovative research and practical applications. Three notable special issues include:

- Special Issue on AI and Machine Learning for 5G Networks: https://www.itu.int/en/journal/j-fet/2021/005/Pages/default.aspx
- 2nd Special Issue on AI and Machine Learning for 5G Networks: https://www.itu.int/en/journal/j-fet/2022/004/Pages/default.aspx
- 3rd Special Issue on AI and Machine Learning for 5G Networks: https://www.itu.int/en/journal/j-fet/2023/004/Pages/default.aspx
- 4th Special Issue on AI and Machine Learning for 5G Networks: https://www.itu.int/en/journal/j-fet/2024/003/Pages/default.aspx

11.3.2 IEEE Publications

Some solutions submitted to the ITU AI/ML Challenge have been featured in IEEE journals and conferences, reflecting the high quality and impact of the research.

11.3.3 ACM Conferences

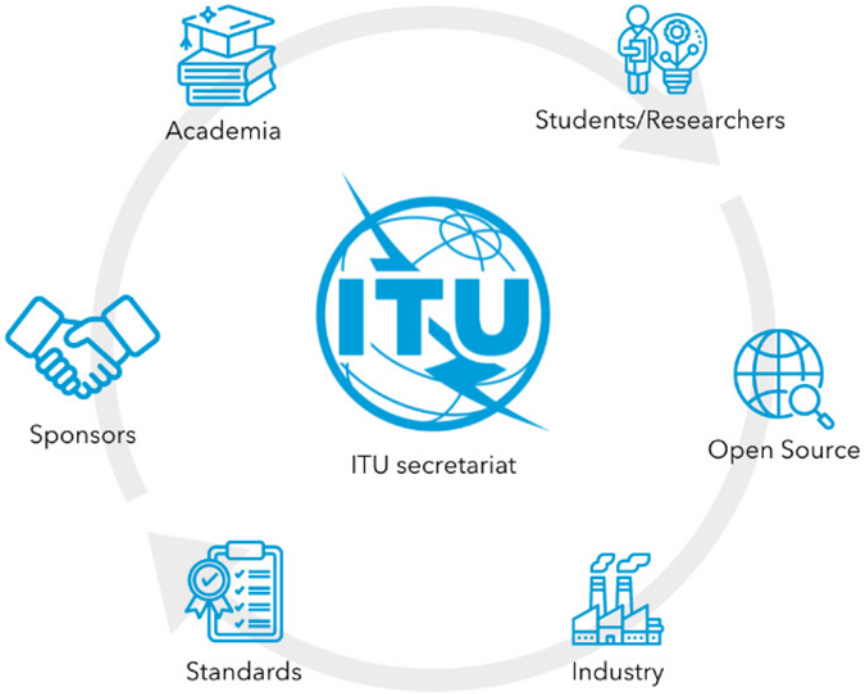
Participants' solutions have also been presented at leading ACM conferences, fostering academic and professional discourse in the AI/ML community.

Through these publications and presentations, the ITU AI/ML Challenge has contributed to the advancement of AI/ML in communication networks. The dissemination of research findings in

journals and conferences not only recognizes the efforts of participants but also inspires further innovation and collaboration in the field.

11.4 Ecosystem creation

Figure 17: Ecosystem



11.4.1 Administrative and Expert Support for the ITU AI/ML Challenge

The ITU secretariat, particularly the Telecommunication Standardization Bureau (TSB), provides essential administrative support for the ITU AI/ML Challenge. This support is carried out in close collaboration with hosts, collaborators, and participants, ensuring the smooth execution of the competitions.

Figure 18: 2024 Challenge announcement in Shanghai during the AI for Good Innovate for Impact at World AI conference

11.4.2 Ecosystem

In the early years of the challenge, the Challenge Management Board and Judging Committee played a crucial role in providing the necessary expertise to successfully run the competitions. These experts have since evolved into a diverse ecosystem that encompasses problem statement development, sponsorship acquisition, and standard development. Their contributions have been invaluable not only in the AI/ML Challenge but also in various associated workshops.

This ecosystem has significantly enriched the ITU AI/ML Challenge, with experts actively participating in AI/ML in communication networks workshops, GeoAI workshops, and tinyML workshops. Their involvement ensures that the challenge remains at the forefront of innovation and continues to attract high-quality participants and collaborators. The synergy between administrative support and expert guidance has been instrumental in the sustained success and growth of the ITU AI/ML Challenge.

The Challenge experts have evolved into a diverse ecosystem enriched the various activities. Their involvement ensures that the challenge remains at the forefront of innovation and continues to attract high-quality participants and collaborators.

12 Judging the submissions

12.1 Common output format

The Challenge participants may produce the following as output:

- Demo video (short, can be uploaded to the Challenge website)
- Demonstration explaining the concept and solution using AI/ML in 5G.
- Brief paper explaining the problem and solution, with a section explaining the relationship to standards e.g. ITU-T Y.3172, Y.3173, Y.3174, and partner resources.

12.2 Additional output for open-source code

In the case that the output will be shared as open source, participants are expected to provide the following, in addition to the outputs described by clause 10.1:

- Final version of the code;
- Reproducibility: It is recommended that participants create a docker image that contains all dependencies and environments required for the algorithm to run;
- ReadMe file containing the description of the algorithm;
- Minimum system configuration required to run the algorithm;
- Details of any data used to train the model (metadata);
- Another key value add would be the alignment of open source with standards – the application of standards-based ML mechanisms in 5G would be encouraged in open source as part of this Challenge. Wherever applicable, outcomes of the Challenge will be encouraged to be shared in an open forum as an open-source project.
- Test cases and results that prove the benefits of the solution.

12.3 Additional output for proprietary code

In the case that the output is proprietary (not open source), participants are expected to provide the following, in addition to the outputs described by clause 10.1:

- Reproducibility: It is recommended that participants create a docker image that contains all dependencies and environments required for the algorithm to run;
- ReadMe file containing the description of the algorithm;
- Minimum system configuration required to run the algorithm;
- Details of any data used to train the model (metadata);
- Test cases and results demonstrating the benefits of the solution.

12.4 Evaluation Criteria

The final criteria to be used to select winners in the Global Round and the Final Conference will be published by the "Challenge Management Board" (see below).

The final criteria are expected to cover areas such as:

- Novelty & originality
- Status and maturity of technical implementation, and reproducibility.
- Viability & impact on the market (practicality of the solution and significance of its impact)
- Interoperability and mapping to international standards (including ITU standards).

- Performance (evaluation based on performance measures such as accuracy, speed, scalability, and quality).
- Quality of demonstration, documentation, and presentation.

13 Resources

The following resources will be available to the participants of the ITU AI/ML Challenge:

- Mentors: Experts mentoring students to enhance their skills and understanding of AI/ML
- Note: "Mentors" may mentor students' participation in the "students track" or sponsor-nominated students and professionals. The mentors are active throughout the challenge.
- ITU Server with on-prem GPUs and orchestration software provided by JarvisAI
- Networking platform of experts in AI ("Neural Network");
- Standards and pre-standards activities related to AI and machine learning.
- Zindi: An African start-up hosting some of the problem statements of the ITU AI/ML Challenge since 2023
- AIIA – challenge management software hosting problem statements of the ITU AI/ML in the 5G Challenge
- Software: Adlik, ONAP, O-RAN OSC Resources, Acumos
- Cloud Credits (based on partner support)
- Toolsets and APIs from partners (set by sponsors)
- ITU AI/ML Challenge website
- Datasets:
    - hosted on contest platforms: provided by sponsors, partners and collaborators
    - open datasets from e.g. Kaggle, AIcrowd, OpenML
    - Simulated datasets from collaborators

Compute platform

ITU provides a state-of-the-art, free-of-charge computing platform to participants of the Challenge who do not have adequate access to compute in their respective institutions. The computing platform will provide participants with access to:

- Free GPUs and CPUs
- Hosted Jupyter notebook server
- Python kernel
- Pre-installed machine learning packages, e.g. PyTorch and Tensorflow

In some of the problem statements, a baseline or reference solution may be offered which may include implementations using Jupyter notebooks.

14 Benefits

14.1 Benefits for partners and collaborators

The Challenge offers partners the following (see sponsorship package for details):

- The visibility afforded to partners and collaborators will continue throughout the Challenge, from the Challenge announcement through to the Challenge Grand Finale.
- Collaborative feedback from the Challenge for partners: learnings from the Competition phase and Challenge Grand Finale may be looped back into the partner organizations for further advancements in technology.
- Publish the results in the "ITU Journal: *Future and evolving technologies*" (subject to acceptance).

14.2 Benefits for Participants

- Shape the future: Opportunity to define, provide inputs, and shape the technologies related to SDGs and communication networks.
- Create your network: Network with ITU experts and peers.
- Be practical: Platform to gain hands-on experience related to AI/ML and concepts related to SDGs and communication networks.
- Be known: Gain global recognition in the form of prizes, appreciation, and publications of the results in the ITU Journal: *Future and evolving technologies* (subject to acceptance).
- Enact your dreams: Receive support to implement use cases and technology ideas using software and access to platforms, e.g. cloud credits and licenses.
- Be social: Solutions targeted at socially relevant issues may be selected for presentation and demonstration at the AI for Good Global Summit.

14.3 Special Benefits for Certain Sponsor Categories

- Mentoring throughout the Challenge
- Mentoring for post-processing and publishing the results.
- Workshop presentation slots
- Co-branding of the ITU AI/ML Challenge or its constituent tracks.
- Channelling curated output to the sponsoring organization in the form of skills, presentations, standards, open-source, and academic and industry partnerships.

15 Impact

The ITU AI/ML Challenge has had some impact on the field of AI/ML, SDGs, and communication networks. Some areas where the challenge has made contributions includes:

15.1 Advancing Technological Innovation

The ITU AI/ML Challenge has catalysed technological innovation by encouraging participants to develop cutting-edge solutions for real-world problems. This has led to significant advancements in AI/ML applications within communication networks, including energy consumption optimization, network management, and security enhancements.

15.2 Promoting Global Collaboration

The challenge has fostered a global community of AI/ML practitioners, bringing together experts, researchers, students, and industry professionals from over 100 countries. This international collaboration has enabled the sharing of knowledge, resources, and best practices, promoting a collective effort to tackle complex challenges.

15.3 Enhancing Practical Skills

Through hands-on workshops, technical webinars, and mentoring sessions, the ITU AI/ML Challenge has provided participants with practical experience in developing and deploying AI/ML models. This capacity-building effort has equipped participants with valuable skills that are directly applicable to their professional and academic pursuits.

15.4 Contributing to Standards Development

The challenge has facilitated the integration of innovative solutions into ITU standards, ensuring that new technologies are effectively standardized and widely adopted. Participants' contributions have influenced the development of technical specifications and recommendations, particularly in the areas of 5G and autonomous networks. Participants of the challenge also contribute to the work of regional groups such as the Study Group (SG) 13 regional group for Africa

15.5 Addressing SDGs

By focusing on problem statements related to the United Nations Sustainable Development Goals, the ITU AI/ML Challenge has supported efforts to address global challenges such as climate change, environment, health, and sustainable urban development. Solutions developed through the challenge have had tangible impacts on advancing these critical goals.

15.6 Recognizing and Rewarding Excellence

The challenge has provided substantial incentives to participants, including over 127,731 CHF in prize money, certificates of recognition, and opportunities to present their work at prestigious conferences. These rewards have not only motivated participants but also highlighted their contributions to the broader AI/ML and communication networks communities.

15.7 Building a Thriving Ecosystem

The ecosystem of experts, collaborators, and participants developed through the challenge has continued to grow and evolve. This network has become a valuable resource for ongoing and future initiatives, supporting a wide range of activities from problem statement development to sponsorship and beyond.

15.8 Showcasing and Disseminating Research

Solutions and innovations from the challenge have been widely disseminated through journal publications, conference presentations, and workshops. This has amplified the visibility of participants' work and contributed to the global discourse on AI/ML applications in communication networks.

Thus, the ITU AI/ML Challenge has made substantial contributions to technological innovation, global collaboration, practical skill development, standards creation, sustainable development, and the recognition of excellence. Its impact continues to resonate across the AI/ML and communication networks fields, driving progress and fostering a vibrant, collaborative community.

16 Testimonials

Figure 19: Testimonials from Challenge organizers and participants

"Hosting our challenge in the ITU AI/ML challenge was the right choice for us. ITU greatly helped with outreach; they are central to the large number of people participating in our challenge. In addition, their entire organization works like a clock!"
- Albert Cabellos, Professor of Universitat Politècnica de Catalunya and Co-founder of Barcelona Neural Networking (BNN)

"The ITU AI/ML Challenge is a globally influential, professional, and well-organized platform that connects AI experts and practical problems to be solved with the most advanced techniques in the industry. We are happy to see that there were a great number of creative solutions proposed to solve the challenge problems we curated together with ITU."
- Xi Zheng, Technical Expert at Huawei

"Organizing the tinyML Smart Weather Station challenge broadened our perspectives and created new collaboration opportunities, helping us to unleash the full potential of tinyML for positive change."
- Jona Beysens, R&D Engineer at Swiss Technology Innovation Center CSEM

"We have had extensive experience working with ITU over the past three years in the preparation and launch of the GEO-AI Challenge, under the leadership of the UN Open GIS group. ITU has provided an excellent platform for operating the challenge, leveraging their professional technical skills. They have supported both the challenge hosts and participants with an automated accuracy assessment system and computational resources throughout the competition. We look forward to further collaboration with ITU on future GEO-AI Challenges to promote the application of AI within the GIS community."
- Pengyu Hao, Consultant at United Nations Food and Agricultural Organization (FAO)

"The ITU AI/ML Challenges provide an invaluable platform for ML scientists to hone their skills and address real-world problems at the cutting edge of technological advancement. My participation exposed me to a broad range of international challenges, fostering a deeper understanding and expertise on the critical applications of AI/ML in various fields, including 5G/Networking, fusion energy, and satellite data analysis. The series have made me more fit for both the industry and academia than ever before. Therefore, if anything, the ITU AI/ML challenges should keep expanding and collect more problem statements to expose the community further."
- Ndabuye Sengayo, the award-winning Technologist at University of Dodoma

"The TinyML challenge has significantly redirected my career path, transitioning me from electronics to microcontrollers, and now from microcontrollers to AI."
- Kasun Thushara, the award-winning Technologist of the TinyML challenge

"The hackathon provided a platform to translate research ideas into practical solutions. Access to a live leaderboard motivates continuous progress and ultimately unleashes creativity."
- Stella Ofori Ampofo, PhD Candidate at Technical University of Munich

17 Conclusion

The ITU AI/ML Challenge has emerged as a powerful platform for global collaboration, innovation, and the advancement of AI/ML technologies in support of the United Nations Sustainable Development Goals (SDGs). Since its inception in 2020, the Challenge has brought together a diverse community of participants from over 100 countries, spanning students, professionals, industry experts, and academia. Through its carefully curated problem statements, hands-on training, mentoring, and access to real-world data, the Challenge has not only enhanced participants' technical skills but also provided them with opportunities to gain global recognition and contribute to the ITU's standardization processes.

The Challenge's impact extends across multiple domains, including communication networks, geospatial analysis, tinyML, climate action, and fusion energy. Each of these areas addresses critical global issues, and the innovative solutions developed through the Challenge have the potential to drive significant progress in their respective fields. By enabling participants to create, train, and deploy AI/ML models, the Challenge has also facilitated the integration of cutting-edge technologies into ITU specifications, ensuring that new advancements are standardized and widely adopted.

Overall, the ITU AI/ML Challenge continues to be a key initiative in the global effort to harness the power of AI/ML for sustainable development. Its success in building a vibrant, skilled, and globally connected community of AI/ML practitioners underscores its importance in shaping the future of technology and its role in achieving the SDGs. As the Challenge evolves and expands, it will undoubtedly continue to inspire and empower participants to contribute to a more inclusive and innovative global society.

Contact

Email: AI5GChallenge@itu.int

Websites:

- AI/ML in 5G Challenge
- GeoAI Challenge
- tinyML Challenge
- Fusion Challenge
- AI for Climate Action Innovation Factory

Annex 1: Data

1 Types of data

Three different types of datasets will be offered: real data, open data, and synthetic data. In some instances, no data will be required to address relevant problem statements.

Real data: This is anonymized network data from operators. The problem statements derived from this data can span across all three tracks but are more likely to play a role in the Network and Verticals tracks. Network data is sensitive and cannot be shared on an open platform and requires a high level of security. However, this type of dataset is important for inference using ML in 5G networks. Different security levels to access training and testing data would be offered to accommodate privacy issues: tracks that run with real data will ensure that isolated, segregated sandboxes (see ITU-T Y.3172) and best practices are in place for secure data handling ("secure track"). Access to this data may be restricted on a role basis and need basis. Secure data-handling techniques (see ITU-T Y.3174) would be put in place for the "secure-track".

Open data: This is data that is open and freely available on the Internet related to network operations. This type of data can span across multiple tracks.

Synthetic Data: This data is from simulations. This will be used to solve problems from different tracks depending on the application.

No data: In some instances, there will be no data required to address relevant problem statements. An example is build-a-thon in which the development of toolsets to support/enable an end-to-end implementation of AI/ML in 5G networks does not require any data.

2 Data sets

***Real data sets*:** This type of dataset is provided by ITU AI/ML Challenge partners. They provide datasets from real networks in accordance with relevant privacy policies.

Open data sets: Compiled list of open datasets is made available on the Challenge website.

Synthetic data sets: Simulation platforms with associated data will be provided by ITU AI/ML Challenge partners.

3 Data privacy policy

Data will be handled in accordance with policies and regulations relevant to the entities and data concerned. Data may be pre-processed and provided using pre-published APIs and may be secured using login/token. Data handling APIs (according to ITU-T Y.3174) will be provided based on the use case and filtered based on the policies of the involved organization(s). Data anonymization may be applied according to relevant policies and regulations. A non-disclosure agreement (NDA) may be included in the terms of participation. In cases where the Challenge involves local user data, the results may be presented in the form of a competition paper not including local user data. API access to data shall be monitored and licensed based on the agreement. Some test data sets may be private and will not be disclosed.

NOTE – Some problem statements use "**restricted data**" which is available only under certain conditions set forth by the host as follows:

Example 1: Restricted data may be made available after signing an NDA.

Example 2: Restricted data may be available only for use within the hosted platform and not for moving out of the hosted platform (i.e. no downloading of data may be allowed).

Example 3: Restricted data may be available to citizens of a particular country or region, e.g. under data privacy regulations of the EU or China.

Annex 2: Problem Statement Sample

The template below is the sample to be used when developing problem statements.

NOTE – please see the document "Problem statements and data resources" on the Challenge website for a compilation of problem statements and data resources.

Table 2: Problem Statement Sample

ID-number	ITU-ML5G-PS-TEMPLATE
Title	Do not modify this particular table, this serves as a template, use the one below.
Description	NOTE 1 – include a brief overview followed by a description about the problem, its importance to IMT-2020 networks and ITU, and highlight any specific research or industry problem under consideration.
Evaluation criteria	NOTE 2 – this should include the expected submission format e.g. video, comma-separated value (CSV) file, etc. NOTE 3 – this should include any currently available benchmarks. e.g. accuracy.
Data source	NOTE 4 – e.g. description of private data which may be available only under certain conditions to certain participants, pointers to open data, pointers to simulated data.
Resources	NOTE 5 – e.g. simulators, APIs, lab setups, tools, algorithms, add a link in clause 2.
Any controls or restrictions	NOTE 6 – e.g. this problem statement is open only to students or academia, data is under export control, employees of XYZ corporation cannot participate in this problem statement, any other rules applicable for this problem, specific IPR conditions, etc.
Specification/Paper reference	NOTE 7 – e.g. arxiv link, ITU-T link to specifications, etc.
Contact	NOTE 8 – email id or social media contact of the person who can answer questions about this problem statement.

Annex 3: Data Sharing Guidelines

The success of the ITU AI/ML Challenge depends on the availability of data and whether entities (or data owners) are willing to share data with others. Rapid and unrestricted sharing of data and resources is essential for advancing the Challenge. However, there are cases where unrestricted data sharing is not possible. In this case, this document addresses measures that can be taken to ensure that data providers can share relevant data with problem solvers or researchers under specific agreements to ensure data integrity. Therefore, having an institutional data-sharing guideline is the first step towards encouraging companies, entities (data providers), collaborators, researchers, and professionals to share relevant data for the challenge.

NOTE – Data providers/owners: defined as entities who have data to share for specific problem statements. This data may be useful for the training and testing of AI/ML models.

This document outlines data management and sharing guidelines. This guideline would help data owners to derive maximum value from their data while protecting the interests of their institution and its members.

1 Data Classification Categories

For the purposes of the ITU AI/ML challenge, we consider the data classification categories[1] below:

Table 3: Data Classification Categories

Data Category	Description
Public/Open Data	Data that can be made publicly available because disclosure is associated with little or minimal privacy impact on individuals and/or organizations. This includes data that is anonymous, aggregated, and non-sensitive data. NOTE – This kind of data can be shared without any restrictions.
Restricted data	Some data are moderately sensitive and cannot be shared publicly (as it is) because disclosure can cause minor privacy impact for an individual, put an individual or community at risk of a privacy incident, or negatively impact an organization's capacity to compete in the market or carry out its activities. Example: measurement data obtained per access network or access network site. NOTE – This kind of data needs to be pre-processed to remove the privacy impact before being shared. Restricted data may be available only under certain conditions set forth by the data provider. Example-1: Restricted data may be made available after signing a NDA. Example-2: Restricted data may be available only for use within the hosted platform and not for moving out of the hosted platform (i.e. no downloading of data may be allowed). Example-3: Restricted data may be available to citizens of a particular country or region e.g. under data privacy regulations of EU or China.

Table 3: Data Classification Categories (continued)

Secret	Also known as "personal, or confidential," this is composed of highly sensitive information that may cause serious distress or increase risk to an individual's safety violate an individual's privacy or impact the compliance to privacy regulations by organizations. This includes personal data that could identify an individual (either on their own or if combined with other data sets), and protection incident management information. NOTE – This kind of data should be avoided from being shared.

In order to determine the sensitivity level of a dataset/information type, it is recommended that the data owner perform a classification of data and risk assessment on the potential impact of the disclosure of each dataset/information type.

For the ITU AI/ML Challenge, we are interested in data that is classified as open or restricted.

2 Options for hosting "restricted data" for AI/ML in the 5G Challenge

Data providers who would like to share data under the "restricted data" category have the following options to choose from;

Option-1: Self-hosted

- Data providers host ML sandbox, including toolsets (e.g. for training) and data handling. These will be on-premises for data providers.

NOTE - ML Sandbox: defined in [ITU-T Y.3172]

- According to step-7 of the "data sharing guideline", user agreements are drafted for access to this ML sandbox. E.g. No download of data may be allowed.
- According to discussions with participants, a list of interested participants for the problem statement (specific to the data provider) is made by ITU and discussed with the data provider.
- The data provider shortlists the candidates who can access the restricted data.
- User agreement is signed, and this makes the participants eligible to compete in the challenge using the restricted data.

Option-2: ITU hosted

- Data providers instantiate ML sandbox, including toolsets (e.g. for training) and data handling. These will be in-premise of ITU (Geneva).
- All other steps remain the same as option-1

NOTE – in this option, ML sandbox maintenance is taken care of by ITU.

NOTE – ITU-hosted ML sandbox may be reused in future editions of such challenges.

NOTE – ITU may facilitate sharing of data between data providers and eligible participants, this may eliminate the need for each participant or team to negotiate with the data provider individually.

3 Risk assessment

Risk assessment must be carried out at an institutional level because data sensitivity is

- **Contextual**: What may not constitute sensitive data and information in one context, may be sensitive in another.

- **Temporal**: Data may not be sensitive now but may become sensitive in the future due to changes in context, such as shifts in policies and/or safety of specific populations.
- **Relational**: One dataset on its own may not be sensitive, however, it could become sensitive if analyzed in combination with other datasets.

4 Classification

Based on the risk assessment, classification must be carried out at the dataset level to identify which of the above data classification categories the data belongs to.

5 Standards, metadata, and documentation

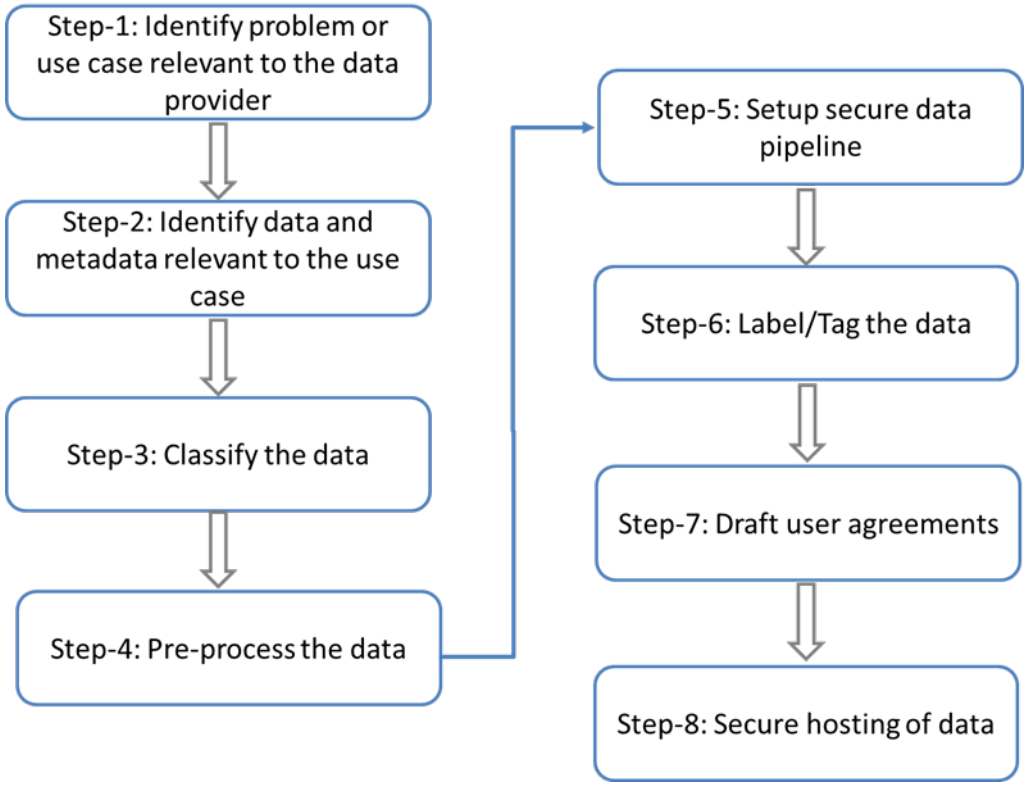
For data sharing to be a success it is important that data are prepared in such a way that those using the dataset have a clear understanding of what the data mean so that they can be used appropriately. To enable this, data owners are encouraged to include with the dataset all the necessary information (metadata) describing the data and their format. This information should include such information as

- the methodology used to collect data
- definitions of variables
- units of measurement
- data format
- file type of the data
- any assumptions made

6 Data Sharing Guidelines

The figure below shows the steps to be considered when an entity (data owner) is planning to share data for the ITU AI/ML Challenge.

Figure 20: Guidelines



Step-1: *Identify the problem or use case relevant to the data provider*. In this context, the data owner should choose what type of problem they would like to pursue or consider during the challenge. This will help determine the data relevant to the problem.

Step-2: *Identify data and metadata relevant to the use case*. The problem and/or data owner determines what type of data they would provide to solve the problem identified in Step-1. In this step, the dataset identified should also contain all the necessary information (metadata) describing the data and their format.

NOTE – ITU can offer expertise to identify data to be collected based on metadata relevant to the use case.

Step-3: *classify the data*. In this step, the data is classified as whether it is open (publicly available) private (provided to challenge participants after certain transformations, under certain rules or user agreements), or secret (not shared at all). This may depend on the internal risk assessment of the data sharing.

Step-4: *preprocess the data*. This is an optional step based on the output of step-3 above. Data anonymization is a type of preprocessing whose intent is privacy protection. It is the process of either encrypting or removing personally identifiable information from data sets. The entity providing data should decide which information to keep for data to be useful and which to anonymize or transform.

Step-5: *Set up a secure data pipeline*. A data pipeline is a series of data processing steps. It enables a smooth, automated flow of data from one station to the next. It starts by defining what, where, and how data is collected. It automates the processes involved in extracting, transforming, combining, validating, and loading data for further analysis and visualization. Data pipelines consist of three key elements: a source, a processing step or steps, and a destination.

Data pipelines enable the flow of data from an application to a data warehouse, from a data lake to an analytics database, or into an ML pipeline system, for example.

Step-6: *Label/Tag the data. (optional step)* Data labeling is the process of detecting and tagging data samples. The process can be manual but is usually performed or assisted by software. Labeled data is a group of samples that have been tagged with one or more labels. In machine learning, if you have labeled data, that means your data is marked up, or annotated, to show the target, which is the answer you want your machine learning model to predict. In general, data labeling can refer to tasks that include data tagging, annotation, classification, moderation, transcription, or processing. Labeled data highlights data features - or properties, characteristics, or classifications - that can be analyzed for patterns that help predict the target.

Step-7: *Draft user agreements.* A user agreement is an agreement made between the owner, administrator, or provider of a service (data owner) and the user of such a service (challenge participants), that defines the rights and responsibilities of both parties. Privacy policies, terms and conditions, etc. are examples of a user agreement.

Step-8: *Secure hosting of data.* In this step, the data owner or ITU provides a platform for the challenge to store sensitive data (private or secure data) that in a manner compliant with the entity's data-sharing policy. The challenge participants can access the secure data hosted on the platform by signing non-disclosure agreements or user agreements. This data can be accessed by using passwords or tokens.

Annex 4: Host Onboarding Guidelines

This section is intended for new Hosts of the ITU AI/ML Challenge. To have your problem statement ready and accepted for the challenge, you are supposed to make sure the following checklist is satisfied.

Check Point-1: Coordinator: Make sure that you have a person who can run the challenge problem statement and represent your entity in coordination with ITU for the duration of the Challenge.

Check Point -2: **Problem statement**(s) Description: Make sure that you submit your problem statement(s) to ITU using the template provided on the Challenge website.

Check Point -3: **Web-admin**: Set up a local website with a problem description and a link for the dataset. A website and logo should be provided in order for participants to access the site where the description of the dataset and other resources are provided

- If your problem statement requires data, you are required to provide the dataset that participants are going to use in the challenge. We encourage you to provide information or toy examples for your problem statement.
- Some problems might require a "Sandbox" to test the submissions – at this point, we may need a setup with simulators.
- maintain a leaderboard of the top solutions for the problem statement

Check Point -4: **Evaluation**: Make sure that you have a committee (or a person) who can review the code submissions and evaluate the results. Description of what the participants are required to submit, the evaluation criteria, and possible deadlines that follow the ITU Challenge timelines.

Check Point -5: **Funding for Prizes by host:** (money, winner-certificates, etc.) to winners in coordination with ITU. Describe the prizes in your hosted website, apart from the prizes listed in the ITU challenge website.

Check Point -6: **Presentations** to participants: The hosts (problem owner) will have to make a presentation (webinar) to describe the problem, and evaluation (alongside the judges panel). Also, act as mentors to guide the participants and participate in Slack channel for discussion.

Check Point -7: **Marketing**: Publish the host website (in English and local languages) and invite colleagues to participate in the challenge. Marketing (alongside ITU) to attract participants to the problem statement.

* A GitHub repo to host the code from contestants is provided and maintained by ITU.

International Telecommunication Union
Place des Nations
CH-1211 Geneva 20
Switzerland

ISBN: 978-92-61-39451-6

Published in Switzerland
Geneva, 2024

Photo credits: ITU