5TH SCHOOL ON HIGH-PERFORMANCE AND DISRUPTIVE COMPUTING IN REMOTE SENSING

HDCRS - Working Group of the IEEE GRSS Earth Science Informatics Technical Committee (ESI TC)

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SENIOR RESEARCHER CITIUS (CENTRO SINGULAR DE INVESTIGACIÓN EN TECNOLOXÍAS INTELIXENTES)

Centro Singular de Investigación en Tecnoloxías Intelixentes

USC UNIVERSIDADE DE SANTIAGO DE COMPOSTELA

citius.gal

XUNTA DE GALICIA

SCIENTIFIC AREAS

Green and smart computing and devices

- Electronic design of intelligent devices
- High Performance Computing

Support for machine intelligence

- Data and process science and engineering
- Automatic learning and reasoning

Intelligent technologies

- Virtual and augmented reality
- Language tecnhnologies
- Computer vision
- Robotics

Social, economic, ethical and political framework

- Trustworthy AI

R&D RESULTS 2022-24

ARTICLES

78% in **Q1**

49% in **D1**

13% in top 10% **most cited**

21 M €

22% income from **european projects**

TEAM

+150 PEOPLE

30 SENIOR RESEARCHERS

SOME INTERNATIONAL PROJECTS

ERC Consolidator Grant
Nanoscale design using Virtual Reallity

NL4XAI
Interactive Natural Language for Explainable AI **(Coordinator)**

MENELAOS NT
Multimodal Fusion of Sensor Information **(Coordinator)**

hybrids
Hybrid intelligence to monitor, promote and analyse transformations in good democracy practices **(Coordinator)**

MISEL
H2020
Multispectral Intelligent Vision System with Embedded Low-Power Neural Computing

iR4S iRead4Skills
Horizon Europe
Intelligent Reading Improvement System for Fundamental and Transversal Skills Development

SOS food
Horizon Europe
Sustainability Optimization for Secure Food Systems

EDIH DATA4Te
Digital Europe
DIH for the deployment of AI and Data Analytics in SMEs in the primary, biotechnological and health sectors

rePowerSiC
Horizon Europe
EIC Pathfinder Challenges
RePowerSiC: High-efficiency high-power laser beaming in-space systems based on sic **(Coordinator)**

Horizon Europe
EUROHPC-JU
QUEX: Quantum Excellence Center

TINY BLUE DOT FOUNDATION
'Numadelic' VR experiences for improving mental health outcomes in patients facing life-threatening illness

SOME STRATEGIC PROJECTS

nós
Artificial Intelligence at the service of the Galician Language

ILENIA
IMPULSO DE LAS LENGUAS EN LA INTELIGENCIA ARTIFICIAL

CAMELIA
Cátedra USC Plexus de IA aplicada a la Medicina Personalizada de Precisión

PLEXUS TECH

Plexus Tech - USC Chair
in AI applied to personalised precision medicine

Cátedra Televés de MICROELECTRÓNICA

Televes

Televés - USC Chip Chair in microelectronic design

AWARDS

Colexio Profesional de Enxeñaría en Informática de Galicia

Premios SERENIDADE Radio Galicia

Santander X
Spain Award I University 2024

SPIN-OFFS

situm
INDOOR POSITIONING

inverbis.

CONGRESS

ECAI
50th ANNIVERSARY

Santiago will be again the world capital of AI in 2024

CITIUS: SCIENTIFIC AREAS

Devices and computing resources

High performance computing

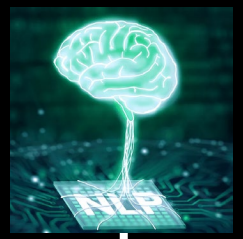
Electronic design of intelligent devices

Intelligent Technologies

Earth Observation

Computer Vision

Virtual and augmented reality



Language technologies

Robotics

Support to machine intelligence

Automatic learning and reasoning

Natural and artificial intelligence

Intelligent systems and environments

Social, economic, ethical and political framework

Trustworthy AI

APPLICATIONS OF REMOTE SENSING

Observing objects and phenomena from a distance without physical contact allows for numerous applications

- Non invasive method in contrast to in situ or on-site observation
- Efficient and continuous observation of the Earth and its changes
- Satellite platforms provide repetitive and consistent view

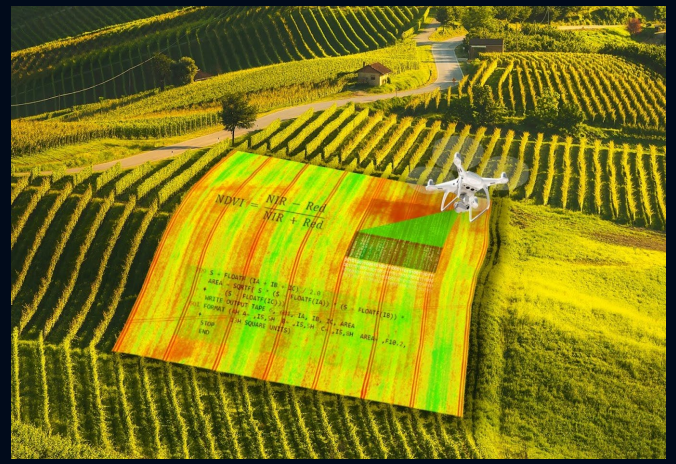
EARTH OBSERVATION AT DIFFERENT SCALES

PRE DL ERA

Earth Observation (EO) is the collection, analysis and presentation of data to better understand our planet.

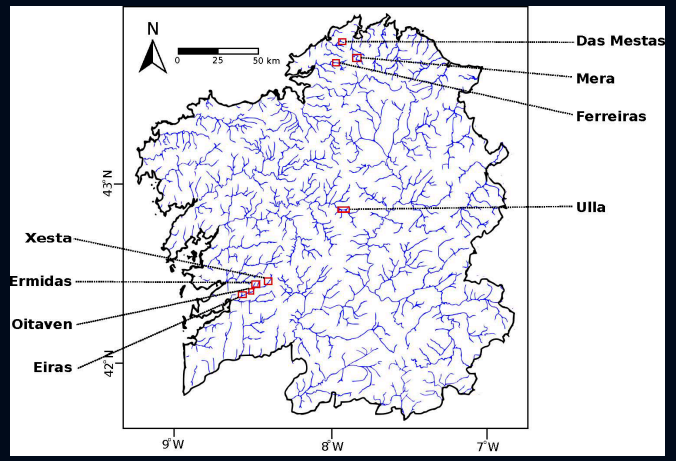
Local : a company, a group of users,…

Time: short



Regional or national: public institutions, companies,…

Time: medium



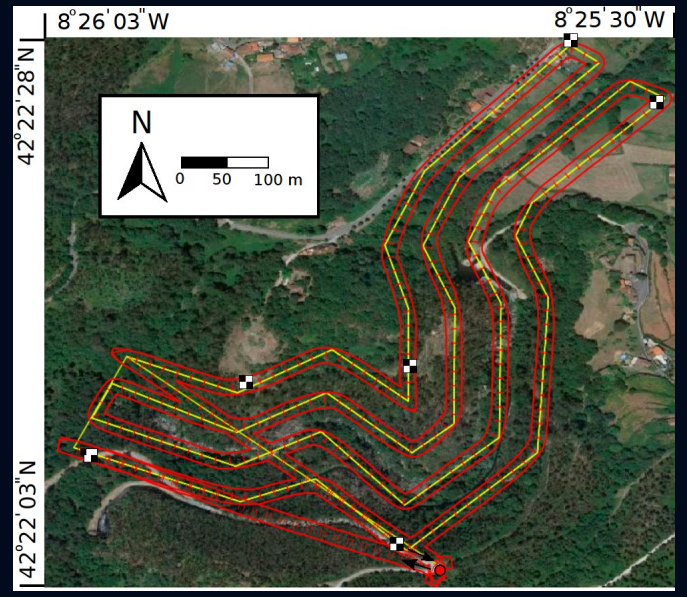
Global: governments, institutions,…

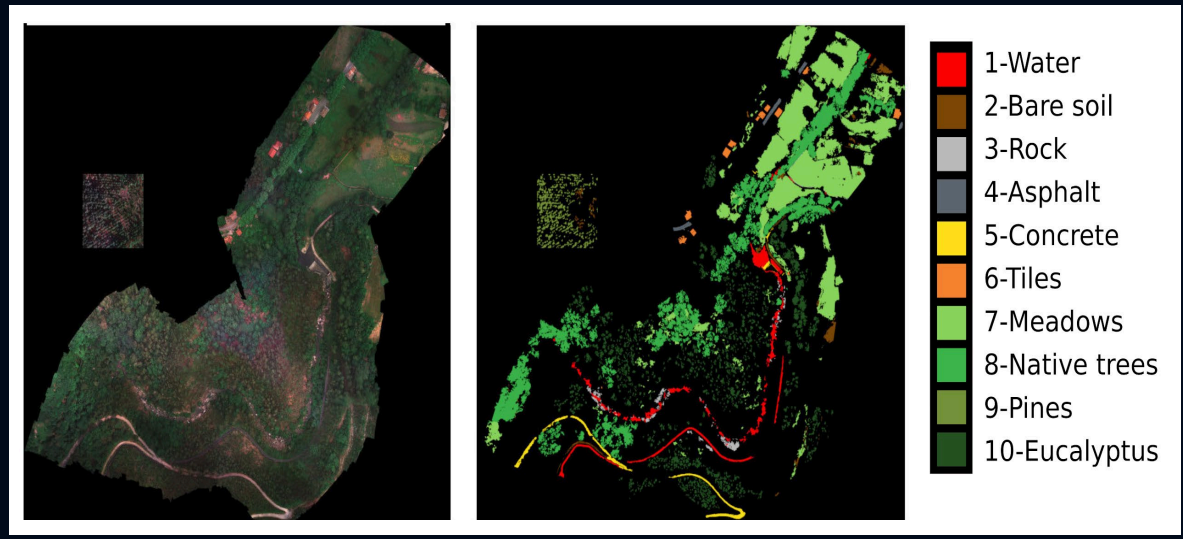
Time: long

EARTH OBSERVATION

Dramatic increase in EO data (multisource and multitemporal information):

- satellite missions and other EO initiatives;
- measurements taken by a thermometer, wind gauge, ocean buoy, altimeter or seismometer;
- photographs taken on the ground or from airplanes;
- radar or sonar images from land-based or ocean-based instruments;
- a birdwatcher’s notes on bird sightings;
- measuring land use change;
- tracking biodiversity and wildlife trends;
- processed information such as maps or weather forecasts.





https://climatedetectives.esa.int/earth-observation-data/

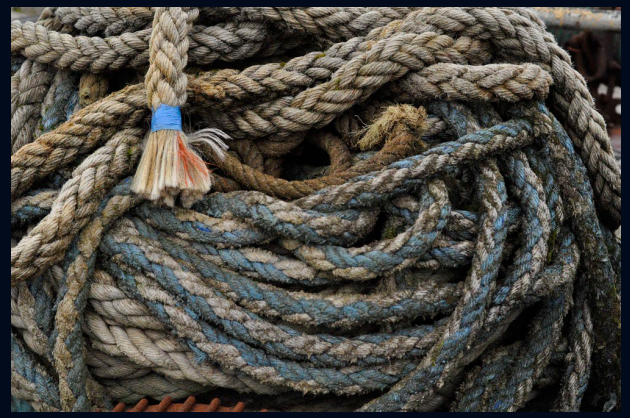
EO IS BEYOND BIG DATA

Volume, Variety, Veracity, … Velocity and …

High Dimensional

Data reflect complex relationships between natural and social phenomena

High Complexity



Data is incorporated in highly complex models

High Uncertainty

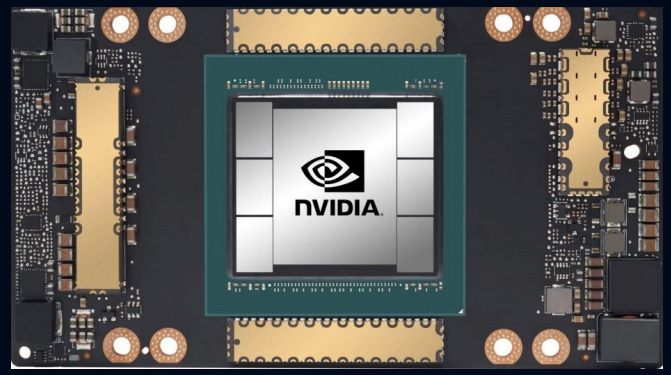
Data errors or incompleteness of data is unavoidable

Hua-Dong Guo, Li Zhang, Lan-Wei Zhu, Earth observation big data for climate change research, Advances in Climate Change Research, Volume 6, Issue 2, 2015, https://doi.org/10.1016/j.accre.2015.09.007.

MACHINE LEARNING AND DEEP LEARNING IN REMOTE SENSING

DL is consistently outperforming all other ML methods on large dataset benchmarks

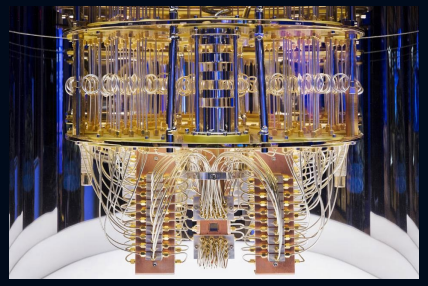
- Convolutional and transformer networks are predominant
  - Self-supervised multi-modal (language-vision) learning: no explicit labels required
- DL is high performance computing
  - Training of models requires accelerators: GPUs, TPUs(Google), in-memory computing chips, Graphcore IPU,…
  - Most breakthroughs require heavy compute power: GPT, DALL-E, AlphaFold,…
  - Quantum Computing as a promising approach



COMPUTING PARADIGMS

Supercomputing

Specialized Hardware Computing



Quantum Computing

Edge Computing

Cloud computing

...

Neuromorphic Computing

https://www.digitalfutures.kth.se/event/neuromorphic-computing-in-sweden
https://www.cesga.es/infraestructuras/computacion/

IEEE GRSS

IEEE is the largest academic and professional Society with ~430,000 members in 160 countries

https://www.grss-ieee.org/

GRSS location: All over the world

Beginnings: Founded in 1961

GRSS mission: Fosters engagement for the benefit of society through science, engineering, applications, and education related to geoscience and remote sensing

Scope: Includes theory, concepts, and techniques of remote sensing of the Earth, oceans, atmosphere, and space, as well as processing, interpretation, and dissemination of this information

GRSS members: ~5,000 members in 94 countries

Chapters: 69 chapters, 22 student chapters, and 11 ambassadors all over the world

Why join the Geoscience and Remote Sensing Society (GRSS)?

To share your ideas, methods, and datasets, and to stay informed about recent developments and job opportunities in your field.

To enjoy discounts when publishing in our top-tier journals and joining our conferences.

To propose and lead special topic journal issues in our high-impact publications.

To make GRSS funds available for students (GRSS schools, IGARSS student grants, GRSS student grand challenges), and young professionals (GRSS sponsorship).

To give back to the community by attending or organizing meetings in your local GRSS chapter and promoting activities in your geographical area.

To organize workshops and events sponsored by GRSS through local chapters.

To foster collaborations that build community through standards and conferences.

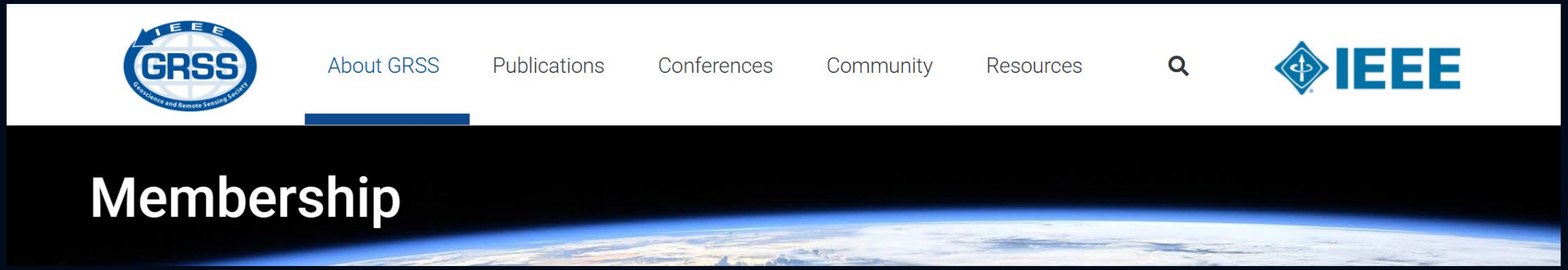
To take part in exclusive mentoring and young professional activities.

To meet other communities and learn from their perspectives.

To access valuable content available to members.

COME ABOARD

JOIN GRSS: https://www.grss-ieee.org/about/membership/



GRSS TECHNICAL COMMITTEES

Earth Science Informatics

Geoscience Spaceborne Imaging Spectroscopy

Instrumentation and Future Technologies

Remote sensing Environment, Analysis and Climate Technologies

Frequency allocations in Remote Sensing

Image Analysis and Data Fusion

Modeling in Remote Sensing

Standards for Earth Observations

Quantum Earth Science and Technology

EARTH SCIENCE INFORMATICS TECHNICAL COMMITTEE (ESI TC)

Objectives

- Advance application of informatics to geosciences and remote sensing
- Evaluating technology to improve data management and governance
- Exchange ideas and share knowledge across interdisciplinary research communities
- Promote and implement best practices in research methodologies and technologies

Chairs

Manil Maskey

Peter Baumann

Gabriele Meoni

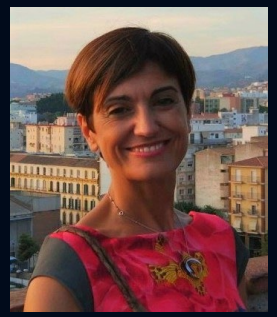
Secretary

Jerika Christman

https://www.grss-ieee.org/about/membership/

ESI WORKING GROUPS

High-Performance and Disruptive Computing in Remote Sensing (HDCRS)


Dora Blanco Heras


Rocco Sedona


Iksha Gurung


Sudan Jha

Databases in Remote Sensing (DBRS)


Muthukumaran Ramasubramanian

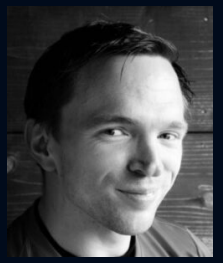

Kesheng (John) Wu


Khalid Belhajjame

AI Foundation Models and Digital Twins for Geoscience (AIFMDTG)


Sujit Roy


Rajat Shinde


Johannes Schmude

High Performance and Disruptive Computing in Remote Sensing (HDCRS) Working Group

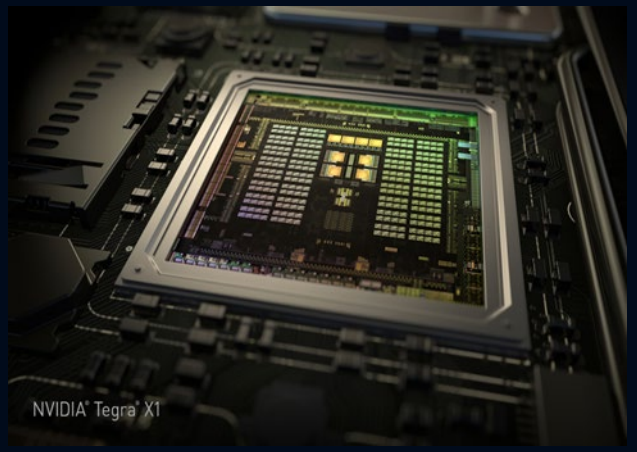
High Performance and Disruptive Computing in Remote Sensing (HDCRS) Working Group

Main Objective:

Connect and support the community of interdisciplinary researchers in remote sensing who are specialized in emerging computing paradigms

The idea:

Innovative computing technologies applied to efficient computation of remote sensing problems

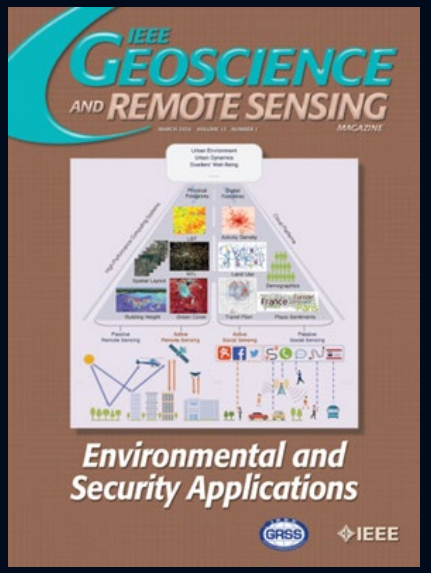


https://www.grss-ieee.org/community/groups-initiatives/high-performance-and-disruptive-computing-in-remote-sensing-hdcrs/

HDCRS WORKING GROUP

- Organizing different activities:
  - special sessions at IGARSS (International EEE International Geoscience and Remote Sensing Symposium)
  - tutorials and webinars
  - podcasts
  - paper journals
  - 5 editions of the Summer School,…

IGARSS
Brisbane 2025

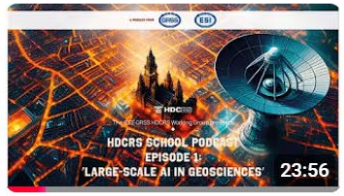


High Performance and Disruptive Computing in Remote Sensing | A podcast from the IEEE GRSS…

Join us on this journey with experts from top institutions worldwide along our 'High Performance and Disruptive Computing in Remote Sensing' School

Quantum Machine Learning in Remote Sensing | HDCRS…

Remote Sensing & High-Performance Computing |…



Large-Scale AI in Geosciences | HDCRS Scho…

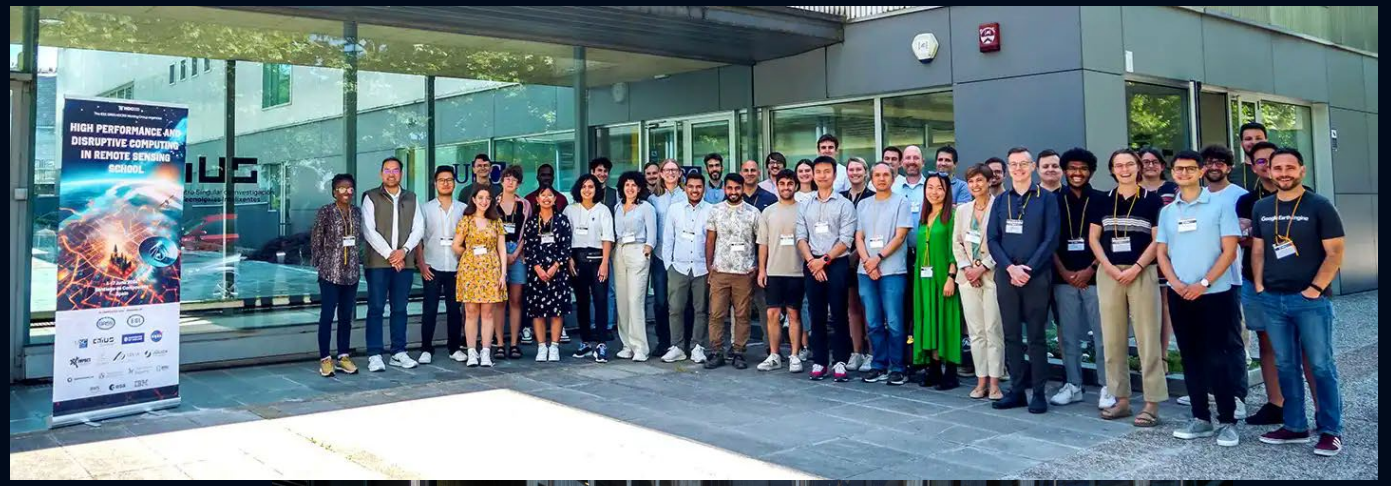
https://www.youtube.com/citiususc

5TH EDITION OF THE HDCRS SCHOOL

Networking with students, young professionals, and senior researchers and professors who work on interdisciplinary research in remote sensing.

Provide understanding on current large AI solutions applied to RS using quantum computing, supercomputing, and cloud computing.

Teaching material and videos will be available at https://www.grss-ieee.org/community/groups-initiatives/high-perfomance-and-disruptive-computing-in-remote-sensing-hdcrs/



AGENDA – TUESDAY JUNE 3TH

Remote Sensing and High-Performance Computing

9:00 – 10:00 (CEST)	Welcome at the University of Santiago de Compostela and Opening of the Summer School	Dora B. Heras and Senén Barro Ameneiro
10:00 - 10:30	IEEE GRSS and HDCRS Working Group	Dora B. Heras
10:00 – 10:30	CESGA: High Performance and Disruptive Computing	Lois Orosa
10:30 - 11:00	Coffee break	-
11:00 - 12:00	Edge computing for Earth Observation: Advances and Challenges in Artificial Intelligence (EO) on board satellites	Gabriele Meoni
12:00 – 13:00	Google Earth Engine for Earth Observation. Introduction.	Emma Verdiguier Eric Smit
13:00 – 14:30	Lunch break	-
14:30 - 15:30	Google Earth Engine for Earth Observation (Hands-on)	Emma Verdiguier Eric Smit
15:30 - 16:00	Coffee break	-
16:00 – 17:00	Google Earth Engine for Earth Observation (Hands-on)	Emma Verdiguier Eric Smit
20:30 - 22:00	Social Dinner	-

AGENDA – WEDNESDAY JUNE 4TH

Quantum Computing for Earth Observation

9:30 – 11:00 (CEST)	Introduction to Quantum Computation
11:00 - 11:30	Coffee break /Poster session I
11:30 - 12:00	Quantum Algorithms
12:00 – 13:00	Hands-on Session 1: Qiskit
13:00 – 14:30	Lunch break
14:30 - 15:30	Quantum Machine Learning
15:30 - 16:00	Coffee break
16:00 – 17:00	Hands-on Session 2: Quantum Machine Learning for Satellite Data Analysis with Qiskit
18:30 - 19:30	Guided visit to the Galician Supercomputing Center (CESGA)

Speakers: Artur Miroszewski (Jagiellonian University), Alessandro Sebastianelli (ESA), Amer Delilbasic (Forschungszentrum Jülich and University of Iceland), Francesco Mauro, Silvia Liberata Ullo (University of Sannio), and Radha Pyari Sandhir and Albert Garcia Fernandez (IBM)

AGENDA – THURSDAY JUNE 6TH

Multimodal Foundation Models for EO I

09:30 – 11:00 (CEST)	An introduction to HPC for AI Leveraging HPC for EO applications: opportunities and challenges TerraMind: Introduction and Background Theory and Implementation
11:00 - 11:30	Coffee break /Poster Session 2
11:30 - 13:00	Hands-on Session 1: TerraMind
13:00 – 14:30	Lunch break
14:30 - 15:30	Hands-on Session 2: TerraMind
15:30 - 16:00	Coffee break
16:00 – 17:00	Hands-on Session 3: TerraMind
19:30 - 20:30	Guided Tour of the Old Town

Speakers: Johannes Jakubik (IBM Research), Alexandre Strube, Rocco Sedona, Þorsteinn Elí Gíslason (Forschungszentrum Jülich)

AGENDA – FRIDAY JUNE 6TH

Multitemporal Foundation Models for EO II

09:30 – 11:00 (CEST)	Overview: Fundamentals of Multitemporal foundation models for EO IEEE GRSS ESI, NASA and Foundation models
11:00 - 11:30	Coffee break / Poster Session 3
11:30 - 13:00	Hands on Session 1: Environment Check Finetuning Prithvi EO
13:00 – 14:30	Lunch break
14:30 - 15:30	Hands on Session 2: Deploy Finetuned model
15:30 - 16:00	Coffee break
16:00 – 17:00	Hands on Session 3: Interact with the Deployed Finetuned Models (including the TerraMind model)

Speakers: Manil Maskey and Sujit Roy (NASA IMPACT), Iksha Gurung and Muthukumaran Ramasubramanian (University of Alabama in Huntsville)

Thank you for your attention