# FAIRNESS

*Daniela Arsenović,*
*University of Novi Sad,*
*Faculty of Sciences*

## EDITOR'S ADDRESS

Dear readers,
We are pleased to present to you the fifth issue of the newsletter devoted to the FAIRNESS COST Action.

Newsletters have the role of showing and spreading the Action's features and deliverables.

Fifth issue brings very interesting topic about gap filling and highlights from short PhD course in Budapest.




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NOVEMBER 2023

# NEWSLETTER

## CONTENT



## ABOUT FAIRNESS

The FAIRNESS action intends to improve standardization and integration between databases/sets of micrometeorological measurements that are part of research projects or local/regional observational networks established for special purposes (agrometeorology, rural and urban microclimate monitoring and others).

Addressing identified challenges requires an effective transboundary network of researchers, stakeholders (extension services and environmental agencies, local authorities and ministries, SME) and civil society (specialized and general public) from Europe and beyond to identify and fill knowledge gaps, standardize, optimize and promote new environmental-tailored measurement and control procedures, enhance research effectiveness and improve dissemination.




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*Prof. Mark Roantree, Dublin City University,*
*School of Computing, Ireland*

## BIOGRAPHY

Prof. Roantree is an Investigator at the Insight Centre for Data Analytics at Dublin City University (DCU) where he leads the Research Challenge on Data Engineering & Governance. His research has a strong multidisciplinary focus, with established academic, industrial and public sector collaborations. He currently has a team of 9 researchers working on machine learning topics such as graph analytics, graph-based neural networks, time series predictions, semi-supervised learning, and predictive models for areas such as climate science, general health, chronic disease management and sports science.

## What is Gap Filling?

*Data is the bedrock for success in the fight against many human challenges but the fight against climate change has its own inherent challenge. Climate data, across all sources, is among the data most likely to be affected by gaps. Gaps may be caused by technological failure where a measuring device ceases to function either temporarily or permanently. Extreme events can damage both large data acquisition devices (satellites) and very small devices (e.g. temperature sensors). At the macro level, satellite data has natural gaps, due to cloud cover or latency issues. At the very levels of granularity, micro-meteorology captures very precise data measures but the focus is too localized to draw conclusions on a wider scale. If we want a holistic picture of climate and climate change, we need to understand and then plug the gaps in our knowledge.*

***GAPS IN DATA OR KNOWLEDGE ARE AN ISSUE FOR WHICH WE MUST FIND SOLUTIONS.***

## How big is the problem?

*A number of years ago, the **Big Think** website published an article entitled "The World's Data Holes, Quantified", where they discussed the creation of the "Unmeasured World" map shown in figure 1. This was used to highlight those areas for which we have vast amounts of data (dark brown), lighter shades to represent countries with lesser amounts of data, and then white to represent those areas of the world where little or no data exists. Taking one white region as an example, they stated "It's not the ice that turns Greenland white, but the lack of data".*

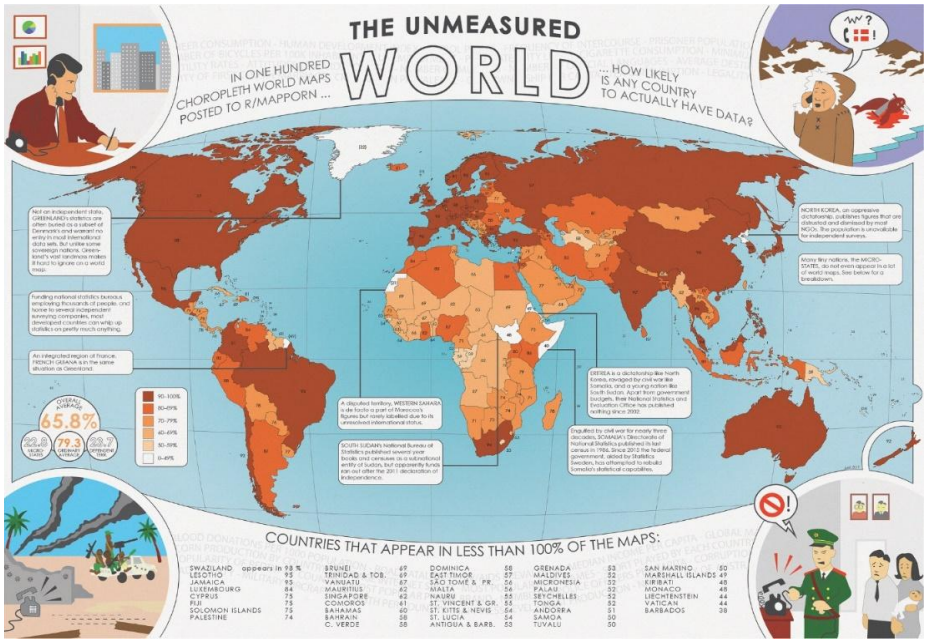


Figure 1. The Unmeasured World, copied from:
https://bigthink.com/strange-maps/the-worlds-data-holes-quantified

*In the article's discussion on the creation of the map of the Unmeasured World (shown above), it described how the mapmaker analysed 100 world maps, summing the number of times each country contributed data. In doing so, the map identified the world's most significant data holes, but also, the list of data-weak countries.*

***THERE ARE SIGNIFICANT DIFFERENCES IN THE GAPS IN OUR DATA FOR DIFFERENT PARTS OF THE GLOBE.***

## Are ready-made solutions available?

*In terms of ready made solutions, two general approaches are to either use an existing repository of data generated by powerful simulations or using existing mathematical interpolation functions. For climate research, an example of the former approach is ERA5, an atmospheric reanalysis of the global climate covering the period from January 1940 to present, produced by the Copernicus Climate Change Service (https://climate.copernicus.eu). This dataset provides hourly estimates of a large number of atmospheric, land and oceanic climate variables. Data covers the globe on a 3-D grid, 30km at the surface level with 137 levels from the surface up to a height of 80km.*
*An second example is the interpolation functions that can be found in languages such as Python where a collection (https://docs.scipy.org/doc/scipy/reference/interpolate.html) of 1-dimensional and multi-dimensional interpolation functions can fill gaps. However, neither of these solutions is guaranteed to provide accurate values to fill missing climate data. A third option for researchers is the adoption of machine learning functions to perform the gap-filling process. With this approach, far more complex solutions can be constructed, which in theory, could lead to more accurate filled data. However, this application of machine learning for climate is relatively new and requires further analysis and study before it replaces existing methods.*

***THERE ARE MANY OPTIONS WHEN CONSIDERING HOW TO FILL GAPS IN DATA.***

## How do I choose the right Gap Filling method?

*At the recent Cost Action workshop on Gap Filling (https://www.fairness-ca20108.eu/workshops/) held in Brussels in August 2023, the steps in gap filling were presented: gap analysis, an important step in understanding the problem and choosing the right solution; data interpolation with Python which requires experimentation with multiple interpolation functions in order to apply the best "fit" for your data; and ERA5 debiasing, which explains how to optimise ERA5 data when filling your gaps this way.*


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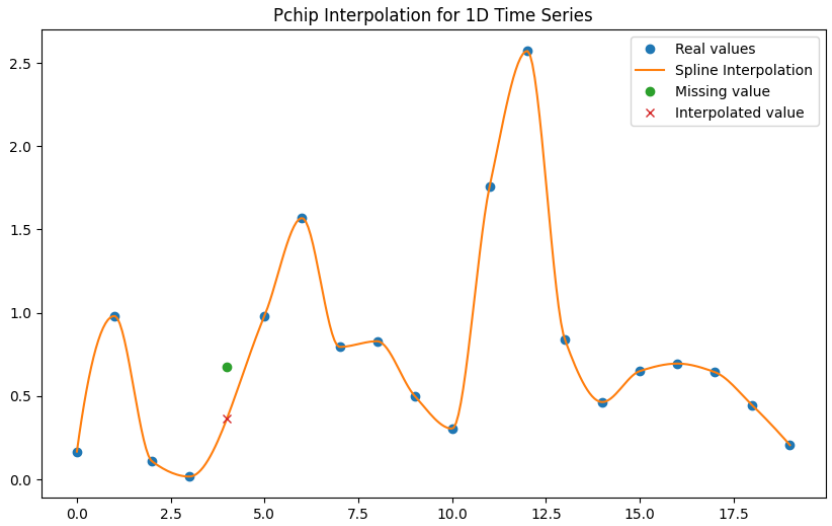


Figure 2. 1D interpolation with Python: curve fitting is crucial

*The process of data gap filling requires existing data to interpolate the missing data. If there is insufficient available data, then gap filling using interpolation functions may not be possible. In figure 2, a high ratio of present to missing data enables a good curve fitting process to ensure a more accurate interpolation result.*

## Collaboration Opportunities for Action Members

*As part of Working Group 2, a number of cost action members have come together to address gaps in climate data in a collaborative multidisciplinary project. Machine learning researchers at Dublin City University are collaborating with climate scientists involved in the Cost Action in an attempt to understand which of the Python interpolation functions are best suited to different datasets, capturing different micrometeorological data with different requirements in terms of gap filling.*

***Until March 31st 2024, there are still opportunities to be involved in this collaboration. Enquiries should be sent to damhan.richardson@dcu.ie.***

**Short PhD course of Prof. Thomas Foken at Department of Meteorology, Eötvös Loránd University (ELTE) Budapest**

**Probing at the Earth's Surface under the Conditions of Climate Change**

Thomas Foken, a retired Professor of Micrometeorology at the University of Bayreuth (Bayreuth Center of Ecology and Environmental Research), Germany was a guest at the Department of Meteorology ELTE between 27 and 30 November 2023. He held a short PhD course in the field of micrometeorology organized by the Doctoral Schools of Earth and Environmental Sciences. He also gave a lecture on the scientific role of Tódor Kármán in the development of micrometeorology in the Hungarian Meteorological Society.

Prof. Thomas Foken has nearly four decades of professional contact with ELTE Department of Meteorology. He visited us several times, held PhD courses, and hosted students and teachers at the Department of Micrometeorology in Bayreuth under Tempus and Erasmus cooperations. In recognition of the fruitful relationship with Hungarian meteorologists, he received the Memorial Medal of the Faculty of Sciences Eötvös Lorand University, and he is a honorary member of the Hungarian Meteorological Society. The visit also provided an opportunity to discuss the planned handbook under the CA20108 FAIRNESS COST Action with title „Guidelines for micrometeorological measurements, quality control standards and data correction".

The series of lectures were advertised at the partner universities, the Hungarian Meteorological Society and the FAIRNESS COST Action website (https://www.fairness-ca20108.eu/)

The first lecture analysed the surface energy budget components, and the energy budget closure problems. The second lecture dealt with new generation of micrometeorological measurement methods. We learnt the application of remote sensing tools, mobile measurements and the opportunities provided by community research, especially in exploring the characteristics of urban heat island and local climate effects. The third lecture focused on evapotranspiration calculation and parametrization methods of the changing climate.

The lecture on the Tódor Kármán's role in the development of turbulence theory was presented in the Hungarian Meteorological Society. The Von Kármán constant used in the surface layer profile calculations preserves his memory. The presentation and the photos can be found on the website (www.youtube.com/watch?v=jCO7r4nA6iE, www.mettars.hu/eloadoi-ulesek/kepek-thomas-foken-eloadoules-2023-november-29/ ). Summaries of the lectures are given in the appendix.

In addition to the Hungarian participants, there were also followers from Montenegro, Germany and Slovakia in the lecture room and via Internet. The number of participants were over twenty.

Seven students from domestic and foreign universities officially completed the course and received corresponding credits. Photos of the lectures are shown in Figures 1 to 5.

Tamás Weidinger, organiser
Department of Meteorology
Eötvös Loránd University, Budapest

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## FAIR Network of micrometeorological measurements

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- Earth and related Environmental sciences: Meteorology, atmospheric physics and dynamics
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**Keywords**

rural micrometeorology, urban micrometeorology, climate change, measurement network, knowledge share platform

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