European Partnership on Metrology
Call 2025 – Health, Integrated European Metrology, Regulation and Research Potential

Selected Research Topic number: **SRT-h17**
Version: 1.0

Title: Metrologically-augmented longitudinal AI benchmark data and metrics for multimodal investigation of neurodegenerative diseases

Abstract

Currently neurodegeneration affects over 10 million people across Europe and, as the population ages, this number is expected to double every 20 years. Early detection of neurodegenerative diseases (NDD) is critical for optimal patient care and prognosis. Recently, the use of AI algorithms with medical imaging data has been identified as a potential tool for diagnosing neurodegeneration. However, a lack of standardisation in data processing and analysis, and robust volumetric measurands, currently impedes measurement comparability. This is especially true for longitudinal, multi-modal studies, i.e. those which involve repeated observations over long periods of times and use multiple different methods or modes of data collection and analysis to gain a more comprehensive understanding. In order to address this, more accurate uncertainty estimates for volumetric neurodegeneration measurands need to be established, as well as robust longitudinal metrics, and comprehensive (reference) benchmark data.

Keywords

Neurodegenerative diseases (NDD), neurodegeneration, Artificial Intelligence, benchmark data, neuroimaging, volumetric measurands, longitudinal multi-modal studies, trajectory modelling

Background to the Metrological Challenges

Neurodegenerative diseases are incurable and debilitating conditions that include Alzheimer's disease and other dementias, Parkinson's disease, Huntington's disease, and motor neurone disease (ALS). Of these, dementias are responsible for the greatest burden of NDD, with Alzheimer's disease representing > 60-70 % of cases. Worldwide there are nearly 10 million new cases of dementia each year and the number of people living with dementia is projected to be 131 million by 2050.

Neuroimaging techniques such as Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) are part of the gold standard methods for diagnosing neurodegeneration. Neuroimaging techniques can provide evidence of structural changes that can be used as diagnostic biomarkers for neurodegeneration. A particularly important biomarker for a dementia diagnosis is brain volume, specifically monitoring shrinkage though longitudinal assessment of neuroimages. However, measuring brain volume requires accurate delineation of regions and accurate computation of volumetric measurands.

Currently, the diversity of neurobiological mechanisms underlying dementia is too complex to fully understand the potential sources of error and uncertainty and their impact on diagnosis. The rapid development of AI in medical imaging has enabled instrument manufacturers to provide advanced data analysis tools, but despite these advancements, there is currently no standardised evaluation framework for assessing the interoperability and reproducibility of AI-powered solutions. Specifically, a lack of standardisation in data processing and analysis of neuroimaging data, inhibits the comparability of volumetric measurands. Furthermore, volumetrics measurands obtained from the same data on the same instrument may vary over time due to software updates which may change the underlying algorithms, pre-processing or hyperparameters of the models used.

The lack of traceability or standardisation in neuroimaging data analysis is a particular problematic for NDD, which require longitudinal and often multimodal assessments for diagnosis. Compounding the issue further is

EURAMET MSU,
Email: part.msu@euramet.org
Metpart.eu

European Partnership Co-funded by the European Union
METROLOGY PARTNERSHIP EURAMET

the lack of associated uncertainties with volumetrics measurands which hinders the assessment of changes in brain structure. In addition, a lack of benchmarking (reference) longitudinal data inhibits the validation of neurodegenerative models. There is also a need for reference data that depicts the variability and distortions routinely seen in clinical imaging, such as reconstruction artefacts, perturbations and blurring.

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The proposal shall focus on the traceable measurement and production of longitudinal AI benchmark data and metrics for multimodal investigations of NDD.

The specific objectives are

1. To develop robust and reproducible methods for quantifying (i) the uncertainty of volumetric time-resolved measurands for neurodegeneration (e.g. hippocampal volume) from neuroimaging data, and (ii) the bias for volumetric measurands derived from MRI data. Volumetric measurands should be validated using NDD biomarker data and cognitive test scores.
2. To develop and validate uncertainty-aware AI -based trajectory modelling for neurodegeneration using multimodal data (e.g. MRI and PET images, patient histories and demographics) to differentiate between fast and slow degeneration.
3. To assess whether data quality metrics can support detection of neurodegeneration in neuroimaging data. This will include determining (i) the limits of common metrics in addressing NDD patient population heterogeneity, (ii) guidelines for longitudinal study model assessment metrics, and (iii) the influence of data quality on AI model performance metrics. AI models should use clinical, multi-modal and metrologically-augmented synthetic data, and identify key sources of uncertainty.
4. To develop tools to combine publicly available gold-standard reference image data with state-of-the art simulations and image distortions to create artificial data sets with controlled levels of clinically routine image distortions. To establish a repository, including these images, of benchmark data for image analysis tasks relevant to NDD (e.g. segmentation, volumetric quantification, and longitudinal monitoring of patients. To demonstrate improved measurement confidence in the diagnosis of NDD by using the outputs of Objectives 1-4 with clinically relevant longitudinal case studies.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by the measurement supply chain, stakeholders (EMN Mathmet), and end users (e.g. clinical stakeholders, manufacturers of medical and healthcare products).

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes, and it is expected that multidisciplinary teams will be required. To enhance the impact of the research, the involvement of the appropriate user community such as medical practitioners, medical (academic) hospitals and industry is strongly recommended, both prior to and during methodology development. Where relevant, proposals are encouraged to build on, or seek collaboration with, existing projects and develop synergies with other relevant European, national or regional initiatives and funding programmes. In particular, links are encouraged with (i) the projects funded under earlier relevant topics of the Horizon Europe programme; or (ii) other relevant European Partnerships.

Proposers should establish the current state of the art and explain how their proposed project goes beyond this. In particular, proposers should outline the achievements of the EMPIR projects 15HLT04 NeuroMET and 18HLT09 NeuroMET2 and Metrology Partnership project 22HLT07 NEuroBioStand and how their proposal will build on those.

Proposers should note that the programme funds the activity of researchers to develop the capability, not the required infrastructure and capital equipment, which must be provided from other sources.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.1 M€ and has defined an upper limit of 2.6 M€ for this proposal.

EURAMET also expects the EU Contribution to the external funded beneficiaries to not exceed 35 % of the total EU Contribution across all selected projects in this TP.

Any industrial beneficiaries that will receive significant benefit from the results of the proposed project are expected to be beneficiaries without receiving funding or associated partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the 'end user' community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the "end user" community (e.g. letters of support) is also encouraged.

You should detail how your proposal's results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Facilitate improved industrial capability, or improved quality of life for European citizens in terms of personal health, protection of the environment and the climate, or energy security,
- Transfer knowledge to the healthcare, pharmaceutical and medical imaging sectors.

You should detail other impacts of your proposed JRP as specified in the document "Guide 4: Writing Joint Research Projects (JRPs)"

You should also detail how your approach to realising the objectives will further the aim of the Metrology Partnership to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically, the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work.

Timescale

The project should be of up to 3 years duration.

Additional information

The links provided in this section are only correct at the time of publication up until the end of the Call year.

These references have been provided by EURAMET.

[1]. EMN Mathmet Strategic Research Agenda
https://www.euramet.org/research-innovation/metrology-partnership/strategic-research-and-innovation-agendas