Maynooth University
Ollscoil Mhá Nuad

Department of Computer Science/
Department of Geography
Research Fellow
Inverse Modelling, Machine Learning & Uncertainty Analysis
(24 Month Contract)

The Project: Terrain-AI

Terrain-AI (T-AI) is a collaborative research project coordinated by Maynooth University, and supported by Science Foundation Ireland's Strategic Partnership Programme involving Teagasc, TCD, UCD, UL and DCU together with primary Industry partner Microsoft. T-AI's core R&D activity revolves around improving our knowledge and understanding of Land Use activity - as this relates to Climate Change. Expanding global populations, agricultural intensification and climate change are increasing pressures on natural and managed environments. To maximise sustainable land use, it is essential that we develop tools and information services that can inform more effective and sustainable management practices. The objective of this research is to integrate a national network of benchmark test-sites and a digital data platform capable of integrating, analysing and visualising large volumes of Earth observation data-streams, including data from satellites, drones and on-site measurements and integrating these datasets into appropriate modelling approaches to simulate greenhouse gas fluxes, sources and sinks. The overall aim of T-AI is to increase our understanding of how management practices can influence carbon emissions arising from the landscape, thus enabling more sustainable land management within environmental and regulatory constraints. The Lead Principal Investigators in Maynooth, Dr Rowan Fealy and Prof Tim McCarthy, are from the Departments of Geography and Computer Science respectively. Given the multi-disciplinary nature of the research area, the project involves collaboration across Geography, Computer Science, the National Centre for Geocomputation (NCG) and the Irish Climate Analysis and Research Units (ICARUS) in Maynooth.

The Role

A critical component to the success of Terrain-AI is the development and implementation of a suite of model based approaches to improve our understand of the exchanges of energy, water and gases that occur between the land surface and the atmosphere. This exciting role will focus on the development and/or implementation of an inverse modelling based approach (e.g. Stochastic Time- Inverted Lagrangian Transport (STILT) model), employing a range of land cover and land use indices,

meteorological data fields and other relevant datasets, to exploit the atmospheric measurements of trace gases at Valentia Observatory, Mace Head, Malin head and Carnsore Point. Outputs will be used to evaluate the empirical and process-based model outputs, at landscape scale, and provide a means to constrain model outputs from the wider suite of models being employed. Outputs should also be capable for use in verification of national greenhouse gas inventories. A key challenge for the various models being employed within Terrain-AI will be to bridge the scale gap between plot and landscape while also attempting to quantify the associated uncertainties – recognising that no single 'optimal' model or approach exists. This role will undertake an assessment of the uncertainties associated with the various modelling approaches, using a range of techniques (e.g. Bayesian, Machine Learning etc), to develop probabilistic predictions including uncertainty estimates for desired quantities. The candidate will be working closely with PIs, Co-PIs and FIs together with other statistical and computational modelling colleagues at MU as well as collaborating institutions to develop an integrated modelling approach to Land Use Management.

Key Responsibilities

- Working with the T-AI Lead, Co-PIs, and wider research team to ensure that the overall aims of Terrain-AI are achieved
- Develop/implement an inverse based modelling approach to derive the footprint/upstream influence/source region on atmospheric trace gas measurements
- Integrating a range of data, including geo-spatial, meteorological, in-situ and other relevant datasets as necessary
- Undertaking Bayesian sensitivity analysis (e.g. Sensitivity analysis to prior assumptions and influence of potentially non-ignorable missingness) and subsequent evaluation of the model simulated outputs against observations and outputs from other model based approaches (e.g. satellite/drone based; biogeochemical, land surface model)
- Develop machine learning models to predict outputs from the suit of models being employed across the research programme
- Undertake testing and simulation approaches to stress test models
- Providing outputs in support of the wider research ambitions and for use in supporting the development of downstream services and policy development
- Lead the publication of papers from the research in international journals
- Support the PIs in monitoring progress and ensure project work-plan, tasks, deliverables together with key milestones are adhered to.
- Assisting with any other related duties assigned by the Principal Investigator(s)

The ideal candidate will have:

Essential
- The ideal candidate will have a PhD in statistics, machine learning, uncertainty quantification, computer science, engineering or a related discipline with a strong focus on mathematics and statistics.
- Demonstrable experience in the application of inverse based modelling approaches for use in estimating source region influence on trace gas measurements
- Experience in the use of a wide range of statistical techniques, including Bayesian analysis/approaches to quantify uncertainty
- Demonstrated ability in data integration techniques
- Experience with coding, programming and scientific computing on Linux systems and data processing applications, such as, Python, R or similar.
- Experience in working with a variety of data from different sources and with different formats
- Ability to work effectively under pressure and manage multiple deadlines
- Commitment to supporting high quality research, development & innovation
- Effective written and verbal communication skills with the ability to present complex information effectively to a range of audiences

- Proven experience demonstrated through scientific publications
- Ability to work independently and as part of a tea

Faculty and Research Institutes

The Faculty of Science and Engineering comprises the Departments of Biology, Chemistry, Computer Science, Electronic Engineering, Experimental Physics, Theoretical Physics, Mathematics and Statistics, and Psychology. The Faculty of Social Sciences incudes the Department of Geography amongst others. The role of both Faculties is to co-ordinate the academic activities of individual departments, to oversee the strategic development of departments, and to support interdepartmental activities and programmes. The University has also developed a number of interdisciplinary Institutes to support excellent research and to build research capacity across disciplines.

Particularly relevant to this project are the following interdisciplinary centres of which the Co Principal Investigators (Fealy and McCarthy) are members

ICARUS

The Irish Climate Analysis and Research UnitS (ICARUS) as part of the Department of Geography at Maynooth University is a national leader in the area of climate change providing integrated climate system research, solutions, data and advice to the scientific community, policy makers and for the benefit of society both nationally and internationally.
Research undertaken at ICARUS aims to advance fundamental understanding of past, present and future climate variability and change, and to provide cutting edge analysis of future impacts, vulnerabilities and adaptation in line with strategic national and international priorities.
In delivering these aims core research strands in ICARUS are focused on the analysis of change in atmospheric, terrestrial and marine environments, palaeoclimatolgy, regional climate modelling, catchment hydrology and water management and the assessment of environmental and socio-economic impacts and adaptation. ICARUS hosts both taught and research postgraduate students.

NCG

NCG is a leading centre for research in the field of Geocomputation, applying computational methods to large spatial data sets from acquisition to analysis, modelling and visualisation. As a leading research centre the NCG is committed to:
- Extending the understanding and utilisation of spatial data from postgraduate programmes to national and international research project engagement
- Applying existing geotechnologies to specific problems for enhanced decision making
- Developing new innovative technologies and applications for real-time response to real world challenges

Department of Computer Science

The Department of Computer Science provides a wide range of undergraduate and postgraduate degree courses in Computer Science, Software Engineering, Multimedia and Mobile Systems along with an extensive research programme leading to M.Sc. and Ph.D. degrees in many exciting areas.
Computers have become a part of everybody's daily life, and in the Department of Computer Science we teach how computer systems work, with a particular focus on software, and we research into how computer systems will develop into the future. Our courses cover a wide spectrum of topics from software to computer hardware, from internal details of operating systems to computer applications, and from software engineering practice to computational theory. Our approach is to instill a thorough understanding of fundamental principles, while developing analytical abilities and practical skills.

We provide excellent facilities for practical work, with most of our modules including a mix of lectures and lab work. Many of our students also spend time working in industry as part of their course. We endeavour to provide a supportive and enjoyable atmosphere for learning - we provide a programming helpdesk, extensive assistance during practical work - and we are always available outside of lectures to help our students.

The University

Maynooth University is one of the four constituent universities of the National University of Ireland and in 2019 was placed in the global top 50 universities under 50 years old in the Times Higher Education World University Rankings. Formally established as an autonomous university in 1997, but tracing its origins to the foundation of the Royal College of St. Patrick in 1795, Maynooth University draws on a heritage of over 200 years' commitment to education and scholarship. It is located in the University town of Maynooth, 25km from the centre of Dublin, Ireland's capital city.

The University is a modern institution - dynamic, research-led, engaged, and grounded in the traditions of liberal education. With more than 12,000 students, Maynooth is Ireland's fastest-growing university, yet we retain a collegial campus culture that is central to our ability to bring significant interdisciplinary expertise to bear in tackling some of the most fundamental challenges facing society today. MU has a distinctive disciplinary profile compared to other universities in Ireland, with research and teaching strengths in humanities and social sciences, science, electronic engineering, business, law and teacher education. The University has major research institutes and centres in the areas of: humanities;, social sciences; mathematics, computation and communication; human health; business and service innovation; climate change; and Geocomputation.

The University has, under the *University Strategic Plan 2012-17*, further enhanced its capacity and reputation for research, transformed its undergraduate curriculum, grown postgraduate enrolments and become even more international, diverse and engaged. MU makes, and is seen to make, an important and distinctive contribution to our national system of higher education.

Maynooth University is now embarking upon a new and exciting phase with the development of the *University Strategic Plan 2018-22,* with a vision to consolidate the international reputation of Maynooth University "*as a university known for outstanding teaching, excellent research, a global outlook, effective engagement with the society we serve, and our distinctive approach to the challenges facing modern higher education.*"

The *University Strategic Plan 2018-22* builds on the institution's strengths and accomplishments, concentrating energy and resources on further development in research and postgraduate education. The strategy focuses on:

- targeted investment in research capacity in a number of priority areas;
- extending the postgraduate portfolio and growing the postgraduate community;
- realising the full benefits of our innovative undergraduate curriculum;
- enhancing the student experience;
- comprehensive and ethical internationalisation;
- equality diversity inclusion and interculturalism as enablers of academic excellence

These strategic goals are underpinned by a commitment to invest, first and foremost in people and opportunities for their development and success, and also in the systems and infrastructure required to achieve scholarly and educational objectives.

Selection and Appointment

- Only shortlisted candidates will be invited to attend for interview;
- Candidates invited for interview will be required to make a brief presentation;
- Appointments will be approved by the President based on the report of the selection board;
- It is anticipated that interviews will be held in the second or third week of January
- The appointment is expected to be effective as soon as possible thereafter.

Equality and Diversity

Maynooth University values the enrichment that comes from a diverse community and seeks to promote equality, prevent discrimination and protect the human rights of each individual. To learn more about our commitment to Equality and Diversity, please read the Maynooth University Equality and Diversity Policy. Additionally, as an Athena SWAN Bronze Award Institute, we are committed to advancing gender equality across the University.

We aim to reflect the diversity of the community we serve and welcome applications from all individuals.

Terms and Conditions

This is a 24 month contract post.

Data Protection Law

Maynooth University will process any personal data provided by you in connection with an application for this role in accordance with the General Data Protection Regulation and the Data Protection Acts 2018.

If your application is successful and you accept an offer of employment at Maynooth University, then your personal data will continue to be processed in accordance with Maynooth University's Staff Data Privacy Notice.

Both the privacy notices and further information relating to data protection, including Maynooth University's other data protection policies and processes, can be viewed at https://www.maynoothuniversity.ie/data-protection

Salary

Research Fellow Level 3 Pt 1:	€55,811
Increment at 12 months to Pt2	€57,430

Appointment will be made in accordance with the Department of Finance pay guidelines.

Application Procedure

Closing Date:

23:30hrs (local Irish time) on **Sunday, 17th January 2021.**

Please note all applications must be made via our **Online Recruitment Portal** at the following link:

https://www.maynoothuniversity.ie/human-resources/vacancies

Applications must be submitted by the closing date and time specified above. Any applications which are still in progress at the closing time on the specified closing date will be cancelled automatically by the system.

Late applications will not be accepted.

Maynooth University is an equal opportunities employer

The position is subject to the Statutes of the University