

VISION

This Alan Turing Institute programme will spearhead the crucial role for Data science and Artificial Intelligence (AI) in enhancing global society's resilience to climatic and environmental changes and in facilitating transitions towards sustainability. It will provide the evidence and tools that are required for informed decision-making, improved risk management, and the technological innovation that will lead us towards a more sustainable interaction with the natural environment.

THE CHALLENGE

The United Nations' 2030 Agenda for Sustainable Development¹ calls for a plan of action for people, planet and prosperity. It aims to take the bold and transformative steps that are urgently needed to shift the world onto a sustainable and resilient path. A robust follow-up and review mechanism for the implementation of the 2030 Agenda requires a solid framework of indicators and statistical data to monitor progress, inform policy and ensure accountability of all stakeholders. This requires high quality, accessible, timely and reliable disaggregated data with comprehensive global coverage to ensure that indicators are comparable over both space and time, but in many countries such data is not routinely available.

Unlocking the full power of data will have far reaching impact across a wide spectrum of environmental areas and is especially crucial in ensuring that SDG targets and indicators are true and accurate representations of the world that the SDGs aim to protect. It will raise the bar in data-driven environment research and will contribute to wider technology development for application across many other sectors. In addition to the quantification of the need for change and tracking developments, Data Science and AI has an arguably even more important role to play: in facilitating change itself through integration of cutting edge data science and AI technology in energy, water, transport, agriculture, aquaculture and other environmentally related systems and by empowering individuals, organisations, businesses and policy makers through the provision of personalized information that will support behavioural change.

Major challenges in this area include:

- 1) Developing and applying cutting edge Data Science and AI to allow the quantification and monitoring of progress against the SDGs, enabling evidence-based decision making for policy makers and industry;
- 2) Increasing our resilience to natural hazards through exploiting both historical and real-time data;
- 3) Driving change by embedding Data Science and AI into new technologies that will lead to more sustainable future interactions with our global, regional and local natural environment.

THE OPPORTUNITY

This presents a fantastic opportunity for the Turing Institute and we propose a flagship research programme with global impact that will demonstrate the power of data in promoting change for the good of individuals worldwide. The programme will promote both fundamental research and the cross-fertilisation of existing technologies, and expertise within the Institute and partners. It will be global in outlook: climate change, healthy oceans, water security, clean air, biodiversity loss, and resilience to extreme events are all global in nature with local consequences. The programme will bring together expertise from the Turing network, and national and international key partners, including the Met Office and the World Health Organization (the custodians of health-related SDGs), together with industry and business.

INTERNAL PARTNERSHIPS

We will perform a detailed scoping exercise, consulting with the Institute to understand the expertise within the partner institutions. There is considerable expertise within Turing partners that aligns with the intensive use of data for environment and sustainability. A far from comprehensive group of examples includes Edinburgh (Finn Lindgren – mapping historical sea temperatures; Chris Dent – energy infrastructure), Newcastle (UKCRIC node for [Urban Analytics](#)), Leeds (Earth Systems and Environmental Sciences). Although this programme represents a distinct theme, there will be close interaction with both the Health and Data-centric Engineering programmes and it will be highly related to a number of existing projects, for example The [Lloyd's Register Foundation](#) (LRF) project on air pollution in London. A core component of this scoping will be discovering the extent of expertise related to SDGs across a variety of areas including, for example:

- **13. Climate Action:** Clean power; Smart transport options; Sustainable production and consumption; Sustainable land-use; Smart cities and homes; climate prediction.

¹ <https://sustainabledevelopment.un.org>

- **15. Life on Land:** Habitat protection and restoration; Sustainable trade; Pollution control; Invasive species and disease control; Realizing natural capital.
- **14. Life Below Water:** Fishing sustainably; Preventing pollution; Protecting habitats; Protecting species; Impacts from climate change; risk to sub-sea cables; deep-sea mining.
- **6. Clean Water and Sanitation:** Water supply and quality; Catchment control; Water efficiency; Adequate sanitation; Drought planning.
- **11. Sustainable Cities and Communities:** Real-time, integrated, adaptive urban management, including **Clean air** (Filtering and capture; Monitoring and prevention; Early warning).

Interested parties together with external partners will be invited to a 2-day workshop at the Turing Institute, combining short presentations of existing work with sessions designed to scope the programme, develop the main themes and develop future collaborations.

EXTERNAL PARTNERSHIPS

The programme will involve a range of strategic partners, including both national and international institutions (e.g. the UK Met office, World Health Organization, Office of National Statistics, UK Hydrographic Office, Ordnance Survey, Northumbria and South West Water, DEFRA, Environment Agency), tech companies (e.g. Microsoft AI for Earth, IBM, Amazon Web Services), re/insurance companies (e.g. Oasis Loss Modelling Framework, Willis), energy companies (e.g. EDF) and potentially many more. The programme will benefit from and build on best-with-best international research collaborations (such as those between Exeter and the Chinese University of Hong Kong, Fudan University and the University of Queensland) and provide a focus for broader international engagement for Turing.

FUNDING OPPORTUNITIES

There is the potential for considerable funding opportunities in the future with increased recognition of the enormous potential for the integration of Data Science and AI within environmentally-related processes and decision-making. The global nature of the programme lends itself naturally to funding opportunities arising through the Global Challenges Research Fund and to seek funding from international business (Microsoft for Earth) and philanthropic bodies (e.g. Bill and Melinda Gates Foundation). This work also has the potential to transform a wide variety of sectors; not just those directly impacted by environmental influences (e.g. the re/insurance sector) but more generally in the recognition of the interaction between the environment and economic prosperity. It also bridges the gap between two of the Grand Challenges within the UK Industrial Strategy⁴: 'Clean Growth' and 'AI and Data Economy'. Data Science and AI in combination with intelligent assets (Internet of Things) and Environmental-sector expertise will be a key enabler for unlocking the promise of new forms of value creation in the circular economy, which has the potential to bring considerable environmental and economic benefits².

PROVISIONAL IDEAS FOR RESEARCH

The increasing availability of large and complex data sets from diverse sources (e.g. environmental monitoring; remote sensing; bio-logging, climate modelling; electronic medical records; social media; and contributions from citizen science) presents an exceptional opportunity to monitor progress against the SDGs and to transform our knowledge of both the effects of environmental change and our planet-transforming power. This massive increase in the availability of environmental data worldwide also has the potential to produce a step change in our resilience to natural hazards ability through enhanced prediction, forecasting and early warning systems, and the development of next generation, data-led, financial instruments, resilient infrastructure and resilience planning.

The scope and direction of the programme will be determined in collaboration with Turing and external partners, but initial ideas might include:

- (i) How to source and collate the data that is required and ensure it is of sufficient quality to form the basis of a process designed to inform global decision making;
- (ii) How to integrate information from multiple, diverse, data sources, acknowledging that each source might represent fundamentally different quantities with uncertainties and biases that vary over both space and time;
- (iii) How to develop methodology that can emulate the underlying geophysical and human processes that drive the SDG and other environmental risk indicators, in a way that will be scalable for use with large, and complex, datasets, allowing the indicators to be calculated, together with associated measures of uncertainty, potentially in near real-time;
- (iv) How to communicate to a wide variety of stakeholders in a manner that will ensure trust in the data and results, ensuring that the potential effects of the 'data journey' are understood, and to produce output in a form that is readily useable in established, and developing, decision making processes.

² <https://www.eea.europa.eu/highlights/circular-economy-to-have-considerable>