



University of Essex



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# TRANSFORMING THE WORLD WITH TRUSTWORTHY DATA SCIENCE



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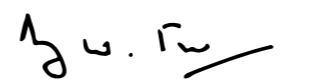
## Trustworthy data science

**The world's digital footprint is growing at breakneck speed. From socialising to healthcare, data is now central to all human activities with more and more being created, stored, and shared across the globe.**

This ever-increasing digital footprint has brought many advantages to our societies, but also poses new fundamental research challenges, from how to store data securely and ensure privacy, to understanding the ethical and legal issues around data.

At Essex we are uniquely placed to respond to the challenge of this data revolution. Our work spans the full spectrum of trustworthy data science and analytics, drawing on expertise from across the University, including data science, artificial intelligence and cyber security.

At the core of this expertise is our Institute for Analytics and Data Science, a centre of excellence connecting academics with businesses, health trusts, local authorities, and government to make the world a better place.



Professor Anthony Forster  
Vice-Chancellor

# Data science and analytics ecosystem

## World-class researchers

Over 200 experts from three faculties and 13 disciplines include:

### Professor Haris Mouratidis

Cyber security and privacy expert and Director of our Institute for Analytics and Data Science.

### Professor Alejandro Quiroz Flores

Chief Scientific Adviser for the county of Essex.

### Professor Maria Fasli

UNESCO Chair in Analytics and Data Science.

### Dr Spyros Samothrakis

Artificial intelligence and machine learning expert and Deputy Director of the Institute for Analytics and Data Science.

### Professor Berthold Lausen

Data science expert.

### Professor Matthew Woollard

Large data sets, ethics and integrity of data expert and Director of the UK Data Archive.

### Dr Faiyaz Doctor

Award-winning artificial intelligence expert.

## Centres of Excellence

- Institute for Analytics and Data Science (IADS)
- Business and Local Government Data Research Centre
- Human Rights, Big Data and Technology Project
- Institute for Social and Economic Research
- Institute of Public Health and Wellbeing
- Centre for Public and Policy Engagement
- UK Data Archive (lead partner of the UK Data Service)

## Strategic partnerships

- Essex County Council
- Essex Police
- Suffolk County Council
- Open Innovation Team in central government
- East Suffolk and North Essex NHS Foundation Trust
- Essex Centre for Data Analytics
- BT
- Philips
- TWI – Essex AI Innovation Centre
- Mid and South Essex NHS Foundation Trust

## Training next generation of data scientists

### IADS Analytics, Data Science and Decision Making Summer School

World-leading academics offer courses across the fields of data science, analytics and decision making.

### Essex Summer School in Social Science and Data Analysis

Provides world-leading social science methods training to postgraduate research students.

### Business and Local Government Data Research Centre

Delivers workshops and tailored training to bridge data analytics skills gaps in machine learning, artificial intelligence and data science.

### CPD Data Science for Public Sector

Delivered by our Chief Scientific Adviser for Essex.

### UK Data Service

Extensive range of courses on data management.

### Data for All

Suite of data science training programmes for all students.



# Building on a history of data excellence

**Essex is dedicated to delivering data-driven research which is making a difference to the world. Professor Chris Greer, Pro-Vice-Chancellor Research, explains more.**

“We have a proven track record in developing high-impact, world-class research that informs policy and practice, shapes public understanding and improves people’s lives.

“When it comes to data science and analytics research, Essex has a long and proud history; we can truly call ourselves pioneering.

“Since the 1960s our researchers have embraced the world of data analytics and data science, challenging conventional approaches and using data in impactful, new and exciting ways.

“The unique Essex approach is all about collaboration – bringing together research strengths from across disciplines to offer fresh and integrated insights and solutions to local, national and international issues.

“Our Institute for Analytics and Data Science (IADS) is a stimulating, rich and supportive environment that unites our expertise and wide interests in data science and analytics and helps foster multidisciplinary and interdisciplinary collaboration.

“This empowers researchers to challenge existing viewpoints and make significant scientific contributions to transform the world we live in through the application of data science and analytics.

“Essex has big ambitions and our strategic growth trajectory saw us more than double our number of researchers in the past decade.

“Our growing research community is enhancing data analytics for the greater good, working with a diverse range of partners to help them tackle a whole range of challenges. But our ambitions don’t stop there.

“Since its inception in 2014, IADS has helped us increase the reach and impact of our research by providing a unique perspective on data and analytics. Our vision is for IADS to continue growing in strength to develop lasting solutions that transform the world and benefit individuals and communities.”

## Essex Facts

**Top** university in the UK for Knowledge Transfer Partnerships



# Trustworthy data science



**Essex has an unrivalled depth of expertise in data science and analytics across disciplines. Our Institute for Analytics and Data Science (IADS) has been instrumental in nurturing and growing that expertise to create a research community of over 200 experts.**

**IADS Director, Professor Haris Mouratidis explains more.**

“IADS academics are working in everything from computer science to mathematical science and life sciences to social sciences – all are committed to unlocking the power of data.

“Although the data revolution has brought many benefits across human life, it introduces new fundamental research challenges.

“These include the need to: classify and share data faster and more efficiently; understand the impact of new technologies such as artificial intelligence (AI) and blockchain on data applications; store, share and use data securely and ensure privacy and reliability; create data strategies that maximise the opportunities provided by large amounts of data and understand the ethical and legal issues related to data science and analytics.

“To deal with such challenges, IADS follows a radical new socio-technical data science approach that explores the relationship between humans, data and technology and introduces trustworthiness at the centre to ensure impactful research and data science solutions people trust.

“This approach puts multidisciplinary and interdisciplinary collaborations at the forefront, it allows us to break intellectual boundaries and provide answers to challenging societal questions and it builds on Essex’s ethos of being bold, looking at how we can do things differently and not just sticking to previous tried and tested approaches.

“IADS researchers are engaging in both fundamental and applied research. We employ expertise in AI and machine learning to create new methods for organisations to improve their operations through better use of data, we develop novel numerical algorithms that improve data analytics and we combine expertise in cyber security and machine learning to improve data protection and trustworthiness of data systems.

“We also apply our expertise to important issues in society – from applying machine learning techniques to study biodiversity in our rivers to using computational methods to understand evolution and phonetic variation in dialects.”

## Essex Facts

The Institute for Analytics and Data Science has over **200** members from **13** academic departments and **3** academic faculties

# Using data to solve real-world issues

## The cornerstone of our Essex approach to data science and analytics is that people are at the heart of everything we do.

Our researchers' commitment to making a positive impact on the world gives our work real value and a unique sense of purpose.

At the heart of that vision is Professor Maria Fasli, our UNESCO Chair in Analytics and Data Science. She is addressing the challenge of helping developing and transitioning countries to gain the data science and analytics skills they need for the 21st century.

Data underpins almost every aspect of human life and there is huge potential for unlocking its benefits for economic growth. However, in many countries there is an acute lack of skills in data science and analytics.

In her UNESCO role, Professor Fasli, a computer scientist and artificial intelligence expert, has been building strong partnerships with collaborators and experts from around the world. She is engaging in research in analytics and data science, hosting a wide range of activities and developing training programmes to address the global skills gap.

Workshops and events have been held in Brazil, China, Malaysia, South Africa, Indonesia and Rwanda and dozens of students have been supported with scholarships to attend the IADS Summer School. Researchers have also been hosted for research visits.

Professor Fasli, the founding Director of our Institute for Analytics and Data Science, said: "By improving people's data literacy, along with access to and understanding of data, we can empower citizens to positively contribute to the governance of their country and transform the economies of developing and transitioning countries into strong, self-reliant digital and knowledge economies."



**"Helping improve skills in data science and analytics is crucial for developing and transitioning countries such as Brazil. Maria's contributions have brought our research projects to the next level. She is a world leader in data science and analytics."**

**Dr Elton Sbruzzi  
Instituto Tecnológico de  
Aeronáutica, Brazil**

## Essex Facts

Home to the **UK Data Archive**, the UK's largest collection of social, economic and population data for over 50 years

# Beyond the research – How we apply our knowledge

**We're leaders in applying scientific advances to public policy, business, health and wellbeing.**

**The Chief Scientific Adviser for Essex – a joint role between our University and Essex County Council – is a unique position in the UK. Here, Professor Alejandro Quiroz Flores explains how his role promotes science in local government and supports using data science for policymaking.**

“With the right expertise you can find knowledge in data which can change lives and transform how organisations deliver public services and how businesses work with clients.

“The strength of our Essex approach is that we bring world-leading social science expertise together with excellent computer science methods to help partners find data solutions for their problems and business challenges.

“Tackling major social issues such as domestic abuse, homelessness, county lines drug networks and health inequalities requires data sharing –

where data owners bring together different sources of data so computer science and social science experts can find insights and solutions.

“Whilst protecting the privacy of individuals, data sharing in an ethical way can create powerful insights which can inform key decisions for the future and benefit for our society.

“We are committed to supporting our partners – from the police and local authorities to businesses and NHS Trusts – to help them develop their data science and analytics skills so they can tackle their data needs in the future.”

## Tackling complex data challenges

The innovative Essex Centre for Data Analytics (ECDA) – a partnership between our University, Essex County Council and Essex Police – tackles complex challenges through collaboration in data science.

ECDA uses data from multiple partners, according to the highest ethical standards, to understand problems affecting the people of Essex, and it works with our researchers and government analysts to find insights and knowledge in their data.

Mechanisms to ensure ECDA meets the highest standards of ethics, data privacy and data protection include the ECDA Data Ethics Committee, where data experts and members of the public review ECDA projects.

# Safeguarding our data and critical infrastructures



**“Digital data sharing is a driving force for our society, from health care records to personal data, but it also introduces several security and privacy challenges and increases the opportunities for data breaches and attacks. Our work at IADS ensures we continue benefiting from data sharing whilst minimising the security and privacy risks.”**

**Professor Haris Mouratidis  
Director, Institute for Analytics and Data Science**

**As society’s dependency on data and digital infrastructures is increasing, the need to protect them from malicious attacks or accidental breaches is crucial.**

At our Institute for Analytics and Data Science (IADS), our work on cyber security and privacy, led by Professor Haris Mouratidis, combines expertise from data science, artificial intelligence (AI) and cyber security to develop novel data-driven techniques that improve analysis of cyber security and privacy risks, threats and vulnerabilities.

ecosystem. Our solutions support forecasting, treatment and responding to advanced persistent threats and handle cyber security and privacy risks, incidents and data breaches.

We are also leading research on creating intelligent methodologies that create and implement mitigation strategies to reduce the risk of attacks and guarantee the highest possible levels of protection.

## **Making an impact through collaborations**

As part of the CyberSANE project we have worked with 16 partners from 11 countries to apply our cyber security and privacy methods for the protection of large critical infrastructures – from energy to supply chain sectors including several European maritime ports.

Working with partners from nine countries, as part of the AI4HealthSec project, we are developing state-of-the-art AI-based solutions to improve the protection of the health care

## **Data privacy and compliance**

Our world-leading methodology on model-based security and privacy offers a new approach that embeds privacy and security principles to:

- the development of data systems
- identifying and visualising risks resulting from technical and human factors
- implementing solutions and policies to ensure data privacy and regulatory compliance

It has been used by the private and public sectors to comply with privacy laws and regulations and improve society’s confidence that privacy is an integral part of the data services provided.



# Using data to understand our natural world

**At Essex we understand that data has the power to help us gain a better understanding of every aspect of our lives, including the world around us.**

**We are using data analytics to gain valuable insights into our natural world – from how the world has evolved to what we can learn about our environment in the future.**

## **Protecting the health of our rivers**

Dr David Clark studies microbial communities which play a major role in the functioning of our planet.

A Research Fellow at the Institute for Analytics and Data Science (IADS), Dr Clark's research focuses on the health of rivers, which are being put under incredible pressures due to human activity.

He analyses river sediment samples using advanced high-throughput DNA sequencing, which enables him to sequence hundreds of millions of microorganisms in just 48 hours.

"Modern DNA sequencers allow us to quickly generate vast quantities of data about environmental microorganisms," he explained. "By applying cutting-edge bioinformatics and statistical analyses to these datasets we can better understand microorganisms, which could help inform how we manage these valuable ecosystems."

## **Reconstructing how life evolved**

IADS Research Fellow Dr Jennifer Hoyal Cuthill conducts research into the patterns and processes of biological evolution, from the deep past to the present day.

By reconstructing how life evolved, and is evolving now, we can make predictions about future evolution or extinction.

The immense complexity of real-world evolution presents considerable challenges, but new computational methods including machine learning offer revolutionary opportunities to understand biological evolution.

Dr Hoyal Cuthill's past research has included making computer models of fractal growth among the earliest animals. Her current research is focusing on adapting new machine learning methods to measure evolution at large, macroevolutionary scales.

# What society can learn from data

## Data can help us understand what makes our society tick and how we can find solutions to the major issues of today and in the future.

Our Institute for Analytics and Data Science Research Fellows are using data analytics in a variety of ways – from getting beneath the reasons for discrimination to helping keep our valuable personal data secure.

### It's not what you said...

Sociolinguist Dr Amanda Cole researches the similarities and differences in people's speech. Using a spectrogram which gives a visual representation of someone's speech, she extracts numerical data to identify subtle speech differences. Her research revealed that people from Essex or London, from working-class or ethnic minority backgrounds were judged most harshly based only on their accent.

### Securing healthcare data

The value of our personal health data makes it extremely vulnerable to being targeted by hackers. Dr Kitty Kioskli is working on a state-of-the-art solution to improve the detection and analysis of cyber-attacks and threats to healthcare information infrastructures. This solution will build risk awareness within digital healthcare and among health professionals, providing them with the capability to react to security and privacy breaches.

### Solutions to large-scale networks

Dr Lina Barakat has research expertise in building AI solutions for complex applications, such as supply chains, that rely on services from multiple providers. This requires designing algorithms that consider individual preferences, as well as solve problems inherent in complex applications, such as trust issues and societal needs.

### Machine learning in social science

Annalivia Polselli is part of a research team using machine learning techniques for the analysis of social science data models. The team are making their computational package available in several programming languages, building a bridge between social and computer sciences.

### Spotlight on political texts

Dr Akitaka Matsuo analyses political texts using natural language processing to gain insights. He uses text from many sources, such as social networking sites, parliamentary proceedings, government reports and international organisations. Current projects include exploring the relationship between British election candidates' gender and the expression of emotions in tweets.





# Understanding memories through data

**When it comes to neural engineering – a growing area of research studying our complex network of nerve cells – Essex is a true leader.**

Our Brain-Computer Interfaces and Neural Engineering (BCI-NE) laboratory is one of the largest and best-equipped of its type in Europe, providing a valuable resource for researchers working on neural engineering technologies for people with and without disabilities.

Artificial intelligence expert Dr Ana Matran-Fernandez, an Institute for Analytics and Data Science Fellow alumna, has ten years' experience in brain-computer interfaces (BCIs), particularly in the processing, analysis and classification of electroencephalography (EEG) data.

Dr Matran-Fernandez also pioneered collaborative BCI research, which uses multiple people's EEG signals to jointly control a single device.

Her main research uses audio-visual stimuli to derive information from the brain. In particular, she is interested in finding neural correlates of the decision-making and memory processes.

Her research into memory processes could help understand why we remember certain things but forget others. She is aiming to find the point when a memory is formed or

retrieved, which could have implications for education and future studies of disorders that impair this process.

## Promoting women in STEM

Essex is committed to the Athena SWAN Charter which recognises commitment to advancing gender equality in higher education.

At Essex, we've made changes to achieve greater gender equality, including closing the gender pay gap at professorial level and developing accessible and inclusive family leave and flexible working policies.

Dr Matran-Fernandez has played a key role in promoting women in STEM (science, technology, engineering, maths) including chairing her department's Athena SWAN team.

Most recently, she has been involved in the British Council-funded Women in Science: UK-Brazil Gender Equality Partnership – a project underpinned by Essex's experience with Athena SWAN.

# Offering bespoke solutions for businesses

## Essex Facts

Top 150 for Business and Economics in THE World University Rankings by Subject 2023

**We help businesses drive innovation, productivity and competitiveness and provide new customer insights to help them deliver better services.**

We are agile, aware and understand the needs of the public and business sector so we can provide pioneering data science and analytics expertise to deliver bespoke solutions – from delivering new services to training the data scientists of the future.

We pride ourselves on a joined-up approach at Essex with disciplines integrated across the University. One of our strengths is that our knowledge exchange team can feed into those different disciplines to offer our partners a bespoke service.

Artificial intelligence (AI) can deliver real benefits for businesses and our new AI For Services hub, hosted at the Institute for Analytics and Data Science, brings together leading Essex academics to design solutions for the professional services industry.

### **Driving innovation**

From Innovate UK-funded Knowledge Transfer Partnerships to innovation vouchers and collaborative research, we are committed to building partnerships between our data scientists and businesses to help them grow.

Our Data Analytics Innovation Vouchers unlock funding for organisations to engage with cutting-edge data expertise. The scheme is delivered by the Business and Local Government Data Research Centre,

which serves as a hub for data and social science expertise which can translate knowledge into practical solutions and support growth.

For companies with larger turnovers, we also offer the Corporate Partnership Fund which can be used to access our researchers to help develop new products, solve problems or develop training schemes.



**“As a council, working with the Business and Local Government Data Research Centre for training on data analytics has proven invaluable for upskilling the workforce and ensuring they are ready for the ever-changing public sector landscape.”**

**Gretl van der Merwe  
Southend-on-Sea City Council**

# Collaboration driving innovation



**“Our partnership with the University of Essex and Innovate UK will give us the combined expertise to take our innovative technology to the next level, keeping our business at the forefront of this developing market.”**

**Will Hitchcock  
CEO, Above**

## **We help businesses drive innovation, productivity and competitiveness and provide new customer insights to help them deliver better services.**

From finance to healthcare, we are helping organisations use machine learning and artificial intelligence (AI) to solve complex, often daunting business challenges.

### **Faster cancer diagnosis**

We have joined forces with award-winning cancer screening and diagnosis healthcare provider Check4Cancer to see how AI could be used to speed up diagnosis and treatment of skin cancer for patients.

By working with Essex AI experts in image recognition, machine learning and algorithm development, Check4Cancer plans to harness both academic excellence and industry expertise to build on its vast bank of skin lesion images and associated clinical data to create an AI model that replicates the clinical excellence of its current clinical skin cancer model.

### **Unlocking new opportunities**

Above is a market leader for solar photovoltaic (PV) drone inspection and software solutions, driven by high-quality drone data.

Using machine learning classification techniques, Above's KTP with Essex AI experts helped automate and reduce the number of human interventions needed when operating drones and processing imagery data collected during an inspection.

A second KTP has now secured funding to explore the next product evolution using digital twin technology, and a Smart Grant developing next-generation robotic techniques to fully automate the flight of the drone.

### **Improving efficiency**

The goal of our award-winning KTP with Mediterranean Shipping Company (UK) Ltd (MSC) – a world leader in global container shipping and haulage – is to better utilise the company's operational and financial data using AI and simulation modelling.

The project is developing transformative data-driven simulation and deep machine learning capabilities for improving efficiencies in MSC's ocean, rail and land-based shipping and haulage operations in the face of global issues around demand, congestion and port space.

# Data-driven powerful partnerships



**“Our KTP with the University of Essex has helped kick start a data science function within G’s, allowing us to answer questions we couldn’t previously explore.”**

**James Green,  
Group Director of Agriculture,  
G’s Growers**

## **Our computer scientists are devising radically different approaches to improving data science solutions through ground-breaking research on artificial intelligence (AI) and machine learning.**

One of these pioneers is AI expert and Deputy Director of the Institute for Analytics and Data Science (IADS) Dr Spyros Samothrakis, who is collaborating with organisations to help drive innovation by using data science expertise.

Dr Samothrakis is skilled at demystifying complex research so businesses can easily understand how AI techniques can solve real-world industry challenges leading to commercial benefits.

### **Precision farming methods**

Independent producer organisation G’s Growers partnered with IADS through a Knowledge Transfer Partnership (KTP) to drive up the quality and volume of crops, using fewer costly resources whilst reducing the environmental impact.

The KTP aims to create an intelligent simulator system by applying novel data science techniques Dr Samothrakis has developed to address the challenge of predicting and managing G’s iceberg lettuce crop.

The machine learning-driven simulator will be used to model growing conditions and interventions, such as

using pesticides, and predict which actions will produce the highest yield of saleable crop.

The project will have a long-lasting impact by embedding the new knowledge and capability gained through the project within a new data science team at G’s.

## **Meeting clients’ needs**

We have embarked on two successful KTPs with Preqin, a market-leading provider of financial data and intelligence on the alternative assets market:

- advanced machine learning to develop faster, more automated extraction of key criteria from investment research
- cutting-edge knowledge graph and network science research to enable the firm to generate advanced insights from huge volumes of dissimilar data

By combining advanced algorithm development with sophisticated machine learning methodologies and network science, the teams were able to make sense of both structured and unstructured data to deliver new insights.

# Training the next generation of data scientists



## Essex has a long history of passing on our ground-breaking research and data analytics expertise by training the next generation of data scientists and analysts.

The use of data science is a journey, and we fully understand that organisations are at different stages on that path. To meet this challenge, we ensure our flexible education and training programmes provide extensive opportunities to support organisations and their staff.

The Essex-based Business and Local Government Data Research Centre offers short courses delivered by its researchers, as well as Data Analytics Innovation Vouchers, to help organisations unlock the hidden value of their data.

We also support more ambitious goals and provide additional assistance such as discounted Masters degrees for our public sector partners so they can learn the skills they need to deliver their own data science insights. Alongside this we offer a structured suite of courses under our CPD Data Science for Public Sector programme, led by our Chief Scientific Adviser.

Our IADS Analytics, Data Science and Decision Making Summer School is delivered by world-leading academics and industry partners from around the globe and offers the chance to network with peers in an invaluable forum for knowledge exchange. The

Summer School is complemented by a series of online training offerings in both fundamental and more advanced topics of data science and analytics.

Now in its 55th year, our Essex Summer School on Social Science Data Analysis provides intensive, world-leading training to postgraduate students.

## Data analytics to inform policymaking

Essex data scientists have trained government officials on how data analytics can be used to inform policymaking.

Since 2019, we've partnered with the Open Innovation Team (OIT), which fosters links between government departments and academics to develop analysis and ideas in key policy areas.

As part of this collaboration, our data science and artificial intelligence experts, with the Chief Scientific Adviser, worked with the OIT to explore how data analytics and insight from data can be used in government to maximize impact.

# Data in action to improve health and wellbeing

## We are using our expertise in data analytics and artificial intelligence (AI) to make real-world improvements to vital hospital services in an exciting health partnership.

Bringing together academic and clinical expertise, the unique £500,000 partnership with the East Suffolk and North Essex NHS Foundation Trust (ESNEFT) will help tackle complex public service challenges, promote evidence-based service provision and preventative solutions to key challenges, and improve the delivery of targeted services to the community.

Using state-of-the-art modelling, machine learning, analytics, automation and robotics it is our hope we can make everyone's experience with the NHS better.

Welcoming the partnership, Dr Hugo Herrera, Head of Analytics at ESNEFT, said: "Like all NHS organisations we have huge amounts of data with a broad utility that, when combined with novel analytical techniques, can provide new insights on how we can improve our approach to planning or delivery of care.

"Through this partnership we will bring together data analysts in the NHS and academia to deliver better outputs from our data for our clinical colleagues."

ESNEFT runs Colchester Hospital, Ipswich Hospital and community

healthcare services in north Essex and east Suffolk. It oversees the clinical health and wellbeing of more than 750,000 people living in Essex and Suffolk.

This partnership focuses on a range of areas including:

- undertaking joint research projects in health and wellbeing, including embedding advanced technologies and techniques in AI and data science in healthcare
- supporting the development of joint research capacity through a new interdisciplinary research group on health
- developing joint project proposals to undertake world-leading research, data collection and analysis to meet UK and global health challenges

"By collaborating with academics in fields such as AI or machine learning, we will be taking further strides in maximising the value of our data for the betterment of patient care", said Dr Alexander Royan, Programme Director for Analytics, Suffolk and North East Essex Integrated Care System.





# Join us on our journey

Data is the driving force behind all aspects of society – from influencing public policy and improving healthcare to better understanding the world we live in and predicting the future ahead of us.

For over 50 years, the University of Essex has been the intellectual home of some of the world's leading experts in data science and analytics.

Our Institute for Analytics and Data Science is a centre of excellence that utilises new forms of data science and advanced analytic techniques to tackle social and business challenges and develop lasting solutions.

We hope you can join us on our journey. We'd love to hear from you if you're interested in partnering with us, funding us, or even if you'd just like to learn about our work.

## **How to get in touch**

For more information, please email the Institute for Analytics and Data Science at [\*\*iads@essex.ac.uk\*\*](mailto:iads@essex.ac.uk)



This booklet is  
printed on FSC  
carbon-neutral paper