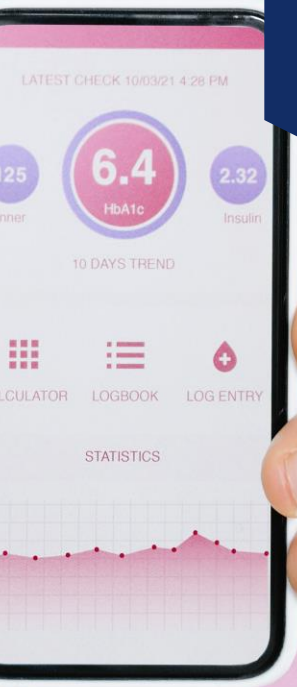UNIVERSITY OF SURREY

DIABETES AND AI
WORKSHOP PROGRAMME

27 June 2022

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INTRODUCTION

Diabetes is a disease that affects millions of people worldwide. Those who have complications suffer from amputations, stroke, heart attack and heart failure. Those who avoid these complications still experience psychological stress, management fatigue and other social and psychological factors that heavily impact their lifestyle.

Recent advances in Nutrition, Genetics, Biology, Psychology and Clinical Practice have helped ease the burden of Diabetes. Developments in Artificial Intelligence (AI) have improved the management of blood glucose with Continuous Glucose Monitoring (CGM) and closed-loop insulin delivery. These advances open the doors to large areas of cross-disciplinary study which are unexplored and often unidentified.

We organised this workshop because we believe that AI can not only enable new technologies, but also be a bridge between different disciplines for diabetes care and management.

This workshop brings together scholars, policy makers and practice stakeholders in a broad range of fields to explore how we can and should use AI to enable people with diabetes to take control of their disease management and give clinicians the tools and information they need.

We are delighted to welcome keynote speakers who will share their experiences of working in AI outside the clinical setting, online management tools for people with diabetes and those working at the forefront of genetics of diabetes. There will be posters of current, ongoing research will be available and collaborative sessions used to help spark discussion, exploring the cross disciplinary research required to make lives of those with diabetes better.

Workshop Organisers
Dr Oscar Mendes, University of Surrey
Dr Shelini Surendran, University of Surrey
Dr Danuta Sampson, University of Surrey

Programme committee:
Prof Vimal Karani, University of Reading
Prof Christian Heiss, University of Surrey
Dr Debbie Cook, University of Surrey
Dr Ben Field, University of Surrey

Administrative support:
Dr Helen Cooper, University of Surrey
Vicki Blamey, IAS, University of Surrey

PROGRAMME

MONDAY 27TH JUNE
James Clerk Maxwell Building (CII)

(BST)

09.30 – 10.00 Registration and refreshments

10.00 – 10.30 Welcome and introduction

10.30 – 11.30 **Session 1 - Healthcare**

Dr Chris Sainsbury: Machine Learning approaches applied to clinical problems in diabetes

Dr Marika Kaakinen: Genome-wide association studies of type 2 diabetes and related traits: paving the way for improved disease prediction and treatment strategies (Online)

11.30 – 11.40 Break

11.40 – 12.15 Session 1 Workshop

11.15 – 13.00 Lunch

13.00 – 14.00 **Session 2 - Lifestyle**

Professor Katherine Barnard: Optimal self-management of Diabetes using Spotlight-AQ

Professor Vimal Karani: Nutrigenetics and precision nutrition for the prevention of type 2 diabetes mellitus

14.00 – 14.10 Break

(BST)

14.10 – 14.45 Session 2 Workshop

14.45 – 15.00 Coffee

15.00 – 16.00 **Session 3 – Technology**

Dr Aisling O'Kane: Personal Health, Care & Wellbeing Technologies 'In the Wild'

Dr Simon Mezgec: Food image recognition systems for dietary assessment using AI (Online)

16.00 – 16.10 Coffee

16.10 – 16.45 Session 3 Workshop

16.45 – 17.00 Final Remarks

ABSTRACTS AND PARTICIPANTS

Machine Learning approaches applied to clinical problems in diabetes
Dr Christopher Sainsbury, Consultant Diabetologist, NHS Greater Glasgow & Clyde

Diabetes as a clinical speciality is ideally positioned to take advantage of advances in data analysis and prediction methods given the wealth of data that is routinely collected from people with the condition. In Scotland we are fortunate to have SCI-Diabetes, a database that captures recorded information from >99% of all people with diabetes, and in the Birmingham group we work with data from both THIN and CPRD.

In this talk I will present and discuss some of our ongoing (and planned) projects which apply machine learning methodologies to routinely collected data from people with diabetes, with the aim of predicting likelihood of developing diabetes associated complications and response to potential therapeutic agents. I will also mention collaborative projects eg the use artificial intelligence to improve treatments for people with multiple long-term conditions (including diabetes), and use of generative methods to produce high quality disclosure-controlled synthetic data.

Dr Chris Sainsbury is a consultant diabetologist, NHS Greater Glasgow & Clyde, NRS Senior Fellow, Honorary Clinical Senior Lecturer - University of Glasgow and Honorary Senior Research Fellow - University of Birmingham. He trained in Diabetes & Endocrinology in Glasgow.

His current research with colleagues in Glasgow and Birmingham is focused on the application of machine learning approaches to diabetes, including using recurrent neural networks and generative adversarial networks to predict outcomes in diabetes, to investigate data-driven classification of diabetes subtypes from large datasets, and also to devise novel solutions to the general problem of clinical data sharing using synthetic datasets.

Genome-wide association studies of type 2 diabetes and related traits: paving the way for improved disease prediction and treatment strategies
Dr Marika Kaaniken, Lecturer in Statistical Multi-omics, Surrey AI Fellow, University of Surrey

Genome-wide association studies (GWAS) have discovered >500 robustly associated genetic regions for the complex trait of type 2 diabetes. The high number of discoveries is a result of constantly increasing sample sizes, including trans-ancestral studies, as well as the strategy to study the genetic architecture of related glycaemic traits in healthy individuals. Recently, we further expanded the GWAS to the previously underutilised, although routinely collected measurement in the clinics, the non-fasting state of glucose, i.e. random glucose. We showed its utility by highlighting novel discoveries, including an underappreciated role of gastrointestinal tract in the control of blood glucose, and providing evidence for pulmonary dysfunction as a diabetes complication. Further, our analyses of low-frequency coding variants in GLP1R, a type 2 diabetes (T2D) treatment target, revealed that optimal selection of GLP-1R agonist therapy in the clinic will benefit from a tailored genetic stratification.

Overall, the collective discoveries from the GWAS of type 2 diabetes and related traits are likely to have an important role in improving the diagnosis of people at risk and the treatment of those already affected by the disease.

Marika Kaakinen holds an MSc degree in statistics and a PhD in genetic and life-course epidemiology from the University of Oulu, Finland. Before joining the University of Surrey in April 2019, she worked as a Marie Curie Fellow and a Research Associate at Imperial College London, UK. During that time, she extended her research to statistical genetics and method development for large-scale genetic and other types of omics data. She applies statistical and AI-based methodology to multi-omics data to better understand complex human traits, including type 2 diabetes and depression. She has also contributed to numerous genome-wide association studies within several international consortia, especially within MAGIC (the Meta-Analyses of Glucose and Insulin-related traits Consortium).

Optimal self-management of Diabetes using Spotlight-AQ

Professor Katharine Barnard, Professor of Health Psychology, Spotlight Consultations, Southern Health NHS Foundation Trust, Bournemouth University, BHR Limited

Existing therapeutic interventions to treat diabetes are well known, yet the majority of people with diabetes do not consistently achieve blood glucose targets (even individual therapy targets) for optimal health, despite the large range of treatment options available. Such outcomes have remained stubbornly poor for decades with <25% adults with diabetes achieving glycaemic targets. The medical healthcare model is not ideally suited to supporting effective diabetes management. In routine clinical care, patient-identified priority concerns may be missed by the care team. Burnout in people with diabetes and healthcare professionals (HCPs) is at an all-time high. This burnout epidemic is both detrimental to healthcare professional well-being, to patient care and to impending physician shortage. There is a pressing need to develop interventions that lead to long term improvements in the patient:professional interface in routine clinical outpatient appointments. The barriers to optimal self-management of diabetes lie beyond A1c-defined glycaemic outcomes. Spotlight-AQ will be presented, with supporting evidence

and underpinning theoretical basis, demonstrating a concrete exemplar of the biopsychosocial model of healthcare, deliverable within the constraints of routine outpatient care.

Katharine Barnard, Professor of Health Psychology, specializes in the psychosocial impact and management of illness and long-term conditions. Her longstanding research career spans models of healthcare, process evaluation, quality of life, psychosocial impact, functional health status, psychological burden and their relationship with biomedical outcomes. Recently, Katharine was awarded FDA MDDT qualification for the INSPIRE psychosocial measures, the first such accolade for diabetes. Katharine Chairs the FDA Global Collaborative Community to reduce incidents of self-injury and suicide by people with diabetes. She sits on the editorial boards of several high impact international journals and research advisory boards and has published over 240 scientific articles. A global leader in psychosocial aspects of diabetes, Katharine leads a ground-breaking programme translating the biopsychosocial model of healthcare into routine care delivery, reducing HCP burden and improving physical and mental health outcomes for people with diabetes.

Nutrigenetics and precision nutrition for the prevention of type 2 diabetes mellitus

Professor Vimal Karani, Professor in Nutrigenetics and Nutrigenomics & Deputy Director for the Institute for Food, Nutrition, and Health, University of Reading

The ability of Nutrigenetics and Nutrigenomics to determine what nutrients will produce the desired impact on metabolic balance is at the core of Personalized Nutrition. Individuals differ from each other in their genetic makeup due to which individuals respond differently to various dietary factors. Diabetes is a heritable trait that arises from the interactions between multiple genes and dietary factors. Although studies in developed countries have examined these interactions extensively, there are no such studies in lower middle-income countries (LMICs). Nutrigenetics has highlighted the complexity of gene-nutrient interactions, but it offers opportunities to re-evaluate criteria used to set dietary guidelines and the contribution of genetic variation to optimal nutrition for individuals from different ethnic groups. To address this missing gap in nutrition science in LMICs, a large-scale collaborative project called GeNuIne (Gene-Nutrient Interactions) Collaboration that aims to develop precision nutrition strategies based on the evidence from nutrigenetic and nutrigenomic studies using cohorts from various ethnic groups has been initiated.

The talk will highlight the existence of genetic heterogeneity in gene–diet interactions across ethnically diverse populations and focus on the significance of precision nutrition approaches for the prevention and management of diabetes.

Vimal Karani is a Professor in Nutrigenetics and Nutrigenomics, as well as the deputy director of the Institute of Food, Nutrition and Health at the University of Reading. Professor Karani has published extensively in areas related to nutrigenetics and non-communicable diseases, and presently has more than 90 peer reviewed publications and book chapters. He has received significant global media attention for his work on nutrition, lifestyle and cardiometabolic diseases. He has received investment from various funding bodies and, in the last 8 years, the grants that he has been associated with are of the value ~£3 million. He won the 2020 UK Nutrition Society's Silver Medal award for his contribution to the world of global nutrition.

Personal Health, Care & Wellbeing Technologies 'In the Wild'
Dr Aisling O'Kane

This talk will outline my ten years of research into technologies to support health and care outside of clinical settings, specifically how diabetes technologies are used, abused, mis-used and not used in the real world. I will look toward the future of co-designing AI/ML enabled diabetes care and widening participation in the design of health, care and wellbeing devices.

Dr Aisling (ASH-Ling) Ann O'Kane is a Senior Lecturer of Human-Computer Interaction for Health at the University of Bristol. She is the Deputy Director of the EPSRC CDT in Digital Health & Care, and is currently the Interim Head of Computer Science. Her research is on the real-world use of technologies for health, care and wellbeing, particularly for diabetes, mental wellbeing, social care, and parenting. Using pragmatic semi-structured qualitative studies and participatory design approaches, she explores how technologies are actually used 'in the wild' and what this means for the design of future technologies with partners from industry, local government, not-for-profits and charities.

Deep learning approaches to automatic food and beverage image recognition
Dr Simon Mezgec, Researcher, Computer Systems Department at the Jožef Stefan Institute, Slovenia

Due to the increasing relevance of a healthy diet in disease prevention, recognizing dietary deficiencies that can lead to actionable results is becoming an important problem to solve in an automated manner. To perform dietary assessment, it is necessary to log food intake. Up to this point, manual methods have been prevalent, but these methods are flawed as they can be inaccurate and they require a high level of effort and motivation. This process can therefore be significantly simplified by automating it. Due to their ubiquity, the most promising approach to automating food recognition is to use smartphones. Using a smartphone camera, food recognition can be performed automatically by recognizing the contents of food images. The state-of-the-art method for recognizing food images is deep learning or more specifically – deep neural networks. In this talk, the food image recognition problem will be introduced and the reasons for its difficulty will be explained. Additionally, previous solutions will be overviewed and the reliance of solutions on input image datasets will be highlighted.

Finally, different solutions that were developed by the author of this talk will be presented. The talk will conclude with a look forward for the food image recognition research field.

Simon Mezgec is a researcher at the Computer Systems Department at the Jožef Stefan Institute. Since 2011, he has been working on computer vision problems such as traffic sign detection and medical image processing. Since 2014, he has focused on food and beverage image recognition, making use of deep learning approaches. In 2017, he published a paper in which he introduced a novel deep learning architecture aimed at food image recognition, called NutriNet. This solution was the first to recognize beverages in addition to food and, due to the size of the training image dataset, it was able to recognize a large number of different foods and beverages. This paper garnered attention from the research community and became an important part of the development of the food image recognition research field. After that, he published several other papers in internationally renowned journals. In 2019, he was selected as a finalist for the DSM Bright Science Award. In 2020, he won second place in the Food Recognition Challenge, the only international food image recognition competition.