

Institution: Ulster University		
Unit of Assessment: Computer Science and Informatics (11)		
Title of case study: ICS3 Digital health technologies in mental health sciences - using machine learning to enhance service design and delivery to people with mental health problems, people in suicidal crisis and people living with dementia		
Period when the underpinning research was undertaken: September 2015 - December 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Prof Maurice Mulvenna	Professor of Computer Science	1990 - present
Dr Raymond Bond	Reader in Data Analytics	2010 - present
Dr Alexander Grigorash	Data Analytics Research Associate	1999 - 2017
Prof Hui Wang	Professor of Computer Science	1996 - 2020
Courtney Potts	Data Analytics Research Associate	2019 - present
Robin Turkington	Data Analytics Research Associate	2020 - present
Prof Kevin Curran	Professor of Cyber Security	1997 - present
Dr Lu Bai	Lecturer in Data Analytics	2019 - present
Period when the claimed impact occurred: July 2018 - December 2020		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact The impacts described in this case study include changes in policy and practice across several organisations as a result of the insights produced by novel application of machine learning to their data, including: I1 – Improved caller management for major national helplines from crisis helpline analysis research; I2 – Major digitalisation of assistance programmes for employees and vulnerable groups from mental health chatbot research; and I3 – National NHS reminiscence app from reminiscence research (the recollection of past events particularly important to support the memory of people with dementia) for people with dementia and their carers.		
2. Underpinning research Since 1996, Ulster University has led in the development of state-of-the-art algorithms in machine learning and data analytics, including association rule mining and other algorithms licensed to SPSS and IBM. In the current research period, Professor Maurice Mulvenna and Dr Raymond Bond led in collaborating with colleagues at Ulster in Psychology and in Nursing, and the resulting underpinning research has been strongly interdisciplinary in nature, including 3 strands of research with 3 accompanying research impacts [I1-I3]: 1. Archetypal caller types identified based on interactional behaviour. National crisis helpline data from Samaritans UK (2017, 21.9M calls), Samaritans Ireland (2016, 3.5M calls) and Lifeline NI (2017, 637K calls) were analysed using machine learning algorithms. Research demonstrated that archetypal caller types were identifiable based on interactional behaviour. Clustering was conducted and five main caller archetypes identified in UK data also matched the five call archetypes identified in the Ireland data set, confirming the same characteristic caller archetypes across two national territories [R1]. Caller archetype		

prediction research identified rule sets generated from C5.0 decision tree classifier algorithm classification could be used to predict caller archetype [R2].

2. Our research with Inspired Wellbeing (2015-2020) developed **artificial intelligence-based chatbot research and delivered a new Inspire Support Hub that provided a chatbot based on the Microsoft Bot Framework with conversational access to a range of information, guidance, screening and intervention tools, tailored specifically to care for employees' wellbeing needs [R3]**. Our research won the Societal Impact award at the National KTP Awards 2020; and
3. **Increase in mutuality, quality of caregiving relationships, and emotional well-being for people living with dementia.** Ulster researchers have long been active in researching reminiscing, chairing the British HCI Workshop on Reminiscence Systems, in Cambridge, UK in 2009 and the CHI Workshop on Bridging Practices, Theories, and Technologies to Support Reminiscence, in Vancouver, Canada in 2011. Subsequently, at Ulster University, in 2014, a quasi-experimental feasibility study investigated the outcomes of a home based, individual specific reminiscence intervention using an iPad app called Inspired for people living with dementia and their family carers. The work was funded by Northern Ireland's Public Health Agency (PHA) and completed in 2018. The increase in mutuality, quality of caregiving relationships, and emotional well-being for people living with dementia scientifically demonstrated for the first time the value of reminiscing [R4]. Our research confirmed that a more individualised relationship-centred approach to reminiscence, facilitated through the use of the Inspired app [R5], generates a positive effect on people living with dementia without negative consequences for family caregivers. These findings, confirmed by our ecological momentary assessment research [R6], support emerging global evidence that suggests individual specific psychosocial interventions are effective in dementia care.

3. References to the research

[R1] O'Neill, S., Bond, R.B., Grigorash, A., Ramsey, C., Armour, C., Mulvenna, M.D., (2018) Data analytics of call log data to identify caller behaviour patterns from a mental health and wellbeing helpline, *Health Informatics Journal*, 25(4): 1722-1738, <https://doi.org/10.1177/1460458218792668>.

[R2] Grigorash, A., O'Neill, S., Bond, R.R., Ramsey, C., Armour, C., Mulvenna, M.D., (2018) Predicting Caller Type Using Call Log Data from a Mental Health and Wellbeing Helpline, *JMIR Mental Health*, 5(2): e47. <https://doi.org/10.2196/mental.9946>.

[R3] Cameron, G., Cameron, D., Megaw, G., Bond, R.R., Mulvenna, M., O'Neill, S., Armour, C., & McTear, M. (2019). Assessing the Usability of a Chatbot for Mental Health Care. In: A. Følstad, H. Halpin, H. Niedermayer, S. S. Bodrunova, A. Smoliarova, O. Koltsova, P. Kolozaridi, & L. Yuldashev (Eds.), *Internet Science: INSCI 2018 International Workshops, St. Petersburg, Russia, October 24–26, 2018, Revised Selected Papers (Vol. 11551, pp. 121-132). Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics); Vol. 11551 LNCS*. Springer Verlag. https://link.springer.com/chapter/10.1007/978-3-030-17705-8_11.

[R4] Laird, E.A., Ryan, A.A., McCauley, C.O., Bond, R.B., Mulvenna, M.D., Curran, K., Bunting, B.P., Ferry, Finola, Gibson, A. (2018) Using mobile technology to provide personalised reminiscence for people living with dementia and their carers: Appraisal of outcomes from a quasi-experimental study, *JMIR Mental Health*, 5(3): e57, <https://doi.org/10.2196/mental.9684>.

[R5] McCauley, C.O., Bond, R.B., Ryan, A.A., Mulvenna, M.D., Laird, E.A., Gibson, A., Bunting, B.P., Ferry, F., Curran, K. (2019) Evaluating User Engagement with a Reminiscence App Using Cross-Comparative Analysis of User Event Logs and Qualitative Data, *Cyberpsychology, Behavior, and Social Networking*, 22(8): 543-551. <https://doi.org/10.1089/cyber.2019.0076>.

[R6] Potts, C., Bond, R., Ryan, A., Mulvenna, M.D., McCauley, C., Laird, L., Goode, D., (2020) Ecological Momentary Assessment Within a Digital Health Intervention for Reminiscence in Persons With Dementia and Caregivers: User Engagement Study, *JMIR mHealth and uHealth*, 8(7): e17120, <https://doi.org/10.2196/17120>

Indicators of research quality

All journal articles have been subject to double-blind peer review practice by internationally based editorial boards and review teams. **[R3]** is associated with awards: Winner, National KTP Best of the Best Awards 2020, Societal Impact Award; Winner, Inaugural Award for Industry-Academic Collaboration, Centre for Behaviour Change Conference on Behaviour Change for Health: Digital and Other Innovative Methods; and Outstanding grade for KTP with Inspire Wellbeing Ltd, 2018. The following grants supported or followed from the research:

- Prof A Ryan, Prof M Mulvenna, Dr C McCauley, Dr L Laird, Dr D Goode, Dr R Bond, “Developing and testing the InspireD reminiscence app”, HSC R&D DARUG, 2019-2023, GBP85,883.
- Prof S O'Neill, Dr S Armour, Dr R Bond, Prof M Mulvenna, Ms C Potts, Mr R Turkington, “Data analytics and dashboard development for Samaritans helplines”, Samaritans Ireland, 2016-2020, GBP62,062.
- Prof M Mulvenna, Dr R Bond, Prof S O'Neill, Dr C Armour, “Mental health chatbot and platform for employee assistance programme” ESRC Knowledge Transfer Programme with Inspire Wellbeing (formerly Carecall (NI) Ltd), 2016-19, graded as ‘Outstanding’ KTP partnership & Winner of CBC Inaugural Award for Industry-Academic Collaboration, 2019, GBP100,300.
- Prof A Ryan, Dr L Laird, Prof K Curran, Prof B Bunting, Prof M Mulvenna, Dr F Ferry, Dr R Bond, “A feasibility study of facilitated reminiscence for people with dementia”, HSC R&D, 2015-2019, GBP320,364.

4. Details of the impact

I1. Improved caller access to helplines: In our research **[R1-R2]**, five cluster archetypes were identified, for example, high frequency callers making thousands of calls over time. Helpline Manager, Samaritans Ireland, said “*The identified cluster archetypes and toolsets developed have become part of the lingua franca for Samaritans, used in analysing awareness campaigns and most recently, examining the impact of COVID-19 on the helpline. The research has now been replicated across the UK as well and the initial tools are being developed into a dashboard.*” **[C1]**

Policy Officer, Samaritans Ireland, said “*The data analytics approach by Ulster has provided us with solid quantifiable metrics of the impact of government policies and other events on public mental health through our helpline. We are now applying these metrics to serve operationally as real time mental health monitors of public levels of wellbeing.*” **[C1]**

Since April 2020, research on caller archetypes and queuing was operationalised in a live dashboard service for the Samaritans, helping them better understand callers in real-time and improve service provision. In using queuing to manage high frequency callers and move their behaviour to that of regular callers, this freed up around 50% of the time previously taken to answer and speak with these callers, enabling Samaritans volunteers to answer significantly more calls. **[C1]**

I2. New assistance programmes for employees and vulnerable groups: Our collaborative research with Inspire Wellbeing **[R3]** co-developed a new digital mental health service called the Inspire Support Hub as part of our award-winning Knowledge Transfer Partnership. **[C2, C3, C4, C5]**

Inspire Chief Executive Officer said, *"If we did not have the foresight, bolstered by the Ulster University team's belief in the direction to take, then our company would now be playing catch up in digital employee access programs and student services."* [C2]

In terms of impact, Inspire Director of Professional Services said, *"Since June 2019, our Inspire Support Hub is used by over 350 clients across a range of sectors. This includes 560,000 employees in the workplace across Ireland, over 180,000 students in further and higher education across Ireland and over 60,000 clients in specialist occupational groups such as the emergency services and our local veteran community"*. [C2]

An Inspire service user said, *"The Inspire Support Hub has really helped me get through the past few months. It is easy to use, with lots of information and I have been able to log in any time. I have been using the Hub to help me manage my drinking which has really worked during the lockdowns. I would have struggled without the help from Inspire."* [C2]

I3. NHS digital reminiscence app: Our work [R4-R6] which presents and assesses an app provided direct evidence to the NHS on the viability of apps for people with dementia, in terms of uptake, sustained engagement, and on the value of event logging to help understand anonymous app usage, leading to the Ulster-coordinated Apple and Google Inspired app development and rollout in 2020. [C6, C7, C8, C9]

Feedback from a person living with dementia said of the app, *"I put everything to do with my life and the people I love inside a little piece of machinery that is wonderful. At the touch of a button, it can reflect everything that has happened to me in my past and the lovely people I've met."* [C6]

'The Songbirds' play, commissioned by the InspiredD team and based on the findings of the research, described as *"insightful and educational"* by the Alzheimer's Society, had audiences of approximately 2,000 across 14 showings. A person living with dementia described the play as *"just like watching myself. it gives a 100% perfect representation of a person with dementia, that is the truth"*. [C6]

The Innovation & Digital Eco-system lead in Health and Social Care, Department of Health in Northern Ireland said: *"Working collaboratively with Ulster University, the InspiredD research and app is part of a wider digital transformation programme in health and social care which is being led by Digital Health & Care NI (DHCNI) with the support of DoH. Using a co-production approach DHCNI works across the health and social care organisations, governmental bodies, academic, industry partners and community & voluntary sector representing patients and carers to develop our digital eco-system. Our partnership with Ulster University on the InspiredD App-research, development and roll-out is an example of this new programme of engagement. The overall aim is to embed clinically assured digital solutions that have been checked for data privacy and security into our clinical pathways."* [C7, C9]

5. Sources to corroborate the impact

- C1. Correspondence from Samaritans on impact on policy and practice.
- C2. Testimonial from Inspire Wellbeing on impact of Inspire Support Hub.
- C3. 'Outstanding' grade certificate from Innovate UK for Knowledge Transfer Partnership.
- C4. ESRC Blog posting on ESRC site.
- C5. CMSWire Press story ("7 Examples of Digital Workplace Chatbots", 8 February 2019).
- C6. "A Feasibility Study of Facilitated Reminiscence for People Living with Dementia". Report to HSC and Correspondence from Dementia NI.
- C7. Testimonial from Public Health Agency on Dementia Apps Library and InspiredD reminiscence app commissioning.
- C8. New online service for those living with dementia, HSC website.
- C9. Inspired app (Google Play/Apple App).