Institution: University of Oxford

Unit of Assessment: 32

Title of case study: The Philosophy of Computer Programming and its Applications

1. Summary of the impact (indicative maximum 100 words)

Professor Peter Millican's research on the philosophy of computer programming, and in particular on issues that arise from the power of computation to mimic important intellectual feats, has had a variety of impacts. One of Professor Millican's interests has been stylometrics, and he has developed software which has been used to corroborate a controversial claim that a certain translation of Goethe's *Faustus* was written by Samuel Taylor Coleridge, to cast doubt on a claim that Barack Obama's autobiography was ghost-written by Bill Ayers, and to help expose J.K. Rowling as the author of *The Cuckoo's Calling*, which she wrote under the pseudonym Robert Galbraith. Another interest is in teacher-friendly and learner-friendly computer programming, particularly their bearing on the Turing test, and this led to his being involved in consultations on Michael Gove's plans to develop the teaching of computer science in schools. His interest in the intersection of philosophy and computation also led to his pioneering the introduction of a new degree course in Oxford in Computation and Philosophy, which in turn inspired the introduction of a similar course in the University of York.

2. Underpinning research (indicative maximum 500 words)

Professor Millican's research interests in the philosophy of computer programming relate particularly to issues that arise from the power of computation to mimic important intellectual feats. His most important philosophical ideas about these issues, which he has been honing for many years, were eventually published in his 2012 paper 'The Philosophical Significance of the Turing Machine and the Turing Test'. His principal conclusion in that paper, which supports the effectiveness of the Turing test, is that if a machine could reliably generate conversation of the quality originally envisaged by Turing himself, then we would have excellent reason for counting the machine as intelligent. There are, however, two caveats to this conclusion. The first is that we would nevertheless have no good reason for counting the machine as consciously aware of anything. The second caveat is that the Turing test is a very poor *measure* of intelligence. But, partly for these very reasons, Professor Millican is emboldened to claim that machines, however well they might or might not be able to mimic human intelligence, have the potential to be outstandingly good tutors. Indeed he takes it to be an open question whether, and in which fields, a machine could teach as effectively as any good human tutor.

As a result of these interests he has also been led to develop several significant programmes in which the power of computation to mimic important intellectual feats, and/or to serve as teaching resources, has been both tested and exploited. A clear example is Signature, a stylometric system that has attracted attention not least because of its ease of use. Professor Millican has been refining and improving this system ever since he was appointed to his current post in Oxford. It is designed to facilitate a stylistic analysis and comparison of texts, with a particular emphasis on author identification, thereby making it serviceable in helping to cast light on problems of disputed authorship. Another example is Elizabeth. This too is a system that Professor Millican has been refining and improving since he has been in Oxford. It was partly developed to complement and illustrate the philosophical problems about the Turing test that he had been exploring. Although he began to develop the system many years ago, he did not properly think through its implications for the Turing test until late in 2005, when he significantly updated it. Elizabeth is based on the well known paradigm of 'chatterbots', namely Joseph Weizenbaum's system Eliza. Indeed it is probably the only system in existence that precisely and transparently mimics Eliza. But it greatly extends Eliza to facilitate the teaching of general principles of artificial intelligence and natural language processing. It uses rules which can be inspected and edited in detail and traced in their precise operation, step by step. Finally there is Turtle, yet another system that Professor Millican has been refining and improving ever since he has been in Oxford. This is an innovative programming

system which uses graphics to explain basic principles of programming and compilation and which also provides a series of carefully graded exercise for self-teaching.

Peter Millican is a Professor of Philosophy and has been a Tutorial Fellow at Hertford College since 2005.

3. References to the research (indicative maximum of six references)

The article on the Turing test, 'The Philosophical Significance of the Turing Machine and the Turing Test', is in S. Barry Cooper and Jan van Leeuwen (eds), *Alan Turing His Work and Impact* (Elsevier, 2012).

A detailed account of Signature is available at http://www.philocomp.net/humanities/signature.

A detailed account of Elizabeth is available at http://www.philocomp.net/ai/elizabeth.

A detailed account of Turtle is available at http://www.philocomp.net/programming/turtlepascal.

Evidence of the quality of this research is, in the case of the article, the prestigious context in which it is published and, in the case of the three systems, the attention devoted to them by the various other scholars who helped to propagate their influence in the ways described below.

4. Details of the impact (indicative maximum 750 words)

(i) The Impact of Signature

In October 2007 Frederick Burwick and James C. McKusick published *Faustus: From the German of Goethe.*[i] This translation of *Faustus* had originally been published anonymously, but their version carried the bold subtitle *Translated by Samuel Taylor Coleridge*. The last chapter of their volume consisted of a 'Stylometric Analysis of the Faust Translations', using Professor Millican's Signature software to corroborate the authors' claim that Coleridge was indeed the translator. From the beginning of 2008 this provoked a major literary controversy that has persisted ever since, in numerous websites and journals (including *The Times Literary Supplement* and *The Guardian*). The society *Friends of Coleridge*, which aims to foster interest in the life and works of Coleridge and his circle, has a page on its website with links to the various responses that they have received to Burwick's and McKusick's claim.[ii]

Secondly, very shortly before the US Election in November 2008, Professor Millican was involved in a controversy about Barack Obama's autobiography *Dreams From my Father*. Some Republican commentators advanced claims that this autobiography was either written or ghost-written by Bill Ayers, a Vietnam-era domestic terrorist. Author Jack Cashill claimed that his own analysis of the book showed Ayers' writing style, and backed this up by citing analyses by American researchers using Professor Millican's Signature software. In 2008 Professor Millican himself was approached by US Congressman Chris Cannon, who attempted to hire him to prove Ayers' authorship using computer analysis. Professor Millican refused, after he was not given any advance assurance that the results would be published irrespective of their outcome. He later carried out his own research and criticized the claim, saying that he could find no evidence for Cashill's hypothesis. The story made the front page of the *Sunday Times* in November 2008, after Professor Millican had written an article about the affair for that paper.[iii]

Finally, in July 2013, *The Sunday Times* again referred to his work, this time after he had used his software to corroborate a suspicion raised by Richard Brooks, the arts editor of the *New York Times*, that the supposedly debut novel *The Cuckoo's Calling* by Robert Galbraith was in fact written by J.K. Rowling under a pseudonym.[iv] Professor Millican noted that this novel was significantly closer in text comparison to other work by Rowling – including her Harry Potter work – than it was to other crime books. Rowling subsequently confessed that the work was indeed hers and commented on her own website, 'I hoped to keep this secret a little longer.'

(ii) The Impact of Elizabeth and its Associated Research on Marketing

In August 2005 Professor Millican received an e-mail from Craig Kolb[v], a business analyst with the company Ask Afrika. Kolb wanted to try to use chatterbot technology in a marketing context, and had identified Professor Millican's Elizabeth system as the most suitable for the purpose, owing to its power, its control, and its flexibility. Working together, Millican and Kolb developed a script that the latter then used to investigate South African consumers' reasons for choosing their mobile phone network. Exploiting the feedback from this exercise, they have in the last year undertaken further work towards producing an online version of Elizabeth capable of augmenting online surveys.

(iii) The Impact of Turtle and its Associated Research on Primary and Secondary Education

Professor Millican's Turtle system is designed to enable beginning students to script their own chatterbots and, in doing so, to learn about artificial intelligence. This has led to his being involved in consultation on Michael Gove's plans to develop the teaching of computer science in schools, in place of the information and communication technology that exists at present. Because of his philosophical interests, Professor Millican was put in touch with Vanessa Pittard, who works at the Department of Education and holds responsibility for the technology in schools strategy and who is leading this initiative. He was subsequently invited to participate in a conference organized by the National Association of Advisors for Computers in Education, a community of educators, technologists, and policy makers concerned with the role of technology in advancing education: this conference took place in Easter 2012. A year later Professor Millican was invited by the Lord Empey of Shandon to a meeting at the House of Lords on the teaching of computer science in schools. This in turn issued in invitations to two HEA workshops at Oxford Brookes for Computer Science and ICT teachers, at both of which he displayed and promoted his software. Several of the teachers decided to try out his software in their schools. These workshops were organized by Alistair Surrall, the Oxfordshire 'Computing in Schools Coordinator', who writes, 'Oxfordshire schools are lucky to have a local university as supportive as Oxford... The workshops were a great success... Some local schools have been trialling Professor Millican's teaching tool Turtle, created to engage students (and teachers) in the new Computer Science curriculum. We're now investigating the possibility of running robotics workshops in local schools using the university's resources to support the work being done in our classrooms.'[1]

Professor Millican also organized a visit for primary school children from Westfields Junior School in Yateley to Oxford, where they used his Turtle system to learn some basic techniques of programming. On a return visit to their school he gave them further exposure to the system, using the most recent hugely improved version of his software. Karine George, headmistress of the school, writes, 'As a consequence of [the first visit, the school IT Manager began]... a programming club... using [Professor Millican's software]. The children... gained a great deal from the experience... We do not want our children to be passive consumers of technology, but better able to use their creative talents to imagine a new future... [Professor Millican's] work in [the] school and at Oxford University... has taken [their] coding to a new level... Our year 6 children have also been involved in the "APPs for Good" programme, normally the reserve of 11 – 18 year olds. This has also involved coding and resulted in them getting to the finals in London.'[2]

Among those who have been following and promoting Professor Millican's work in relation to primary and secondary education is David Brown, the Ofsted National Lead for Information and Communication Technology. He writes, 'It is clear that Professor Millican's research is being put to really effective use in helping to shape the teaching of computer science in both primary and secondary schools.'[3]

(iv) The General Impact of Professor Millican's Work on Higher Education

Professor Millican's interest in the philosophy of computation led him to pioneer a new degree at the University of Oxford in Computation and Philosophy. This in turn inspired the introduction of a similar degree in Computer Science and Philosophy at the University of York, where he was made an Honorary Visiting Professor in Philosophy in 2011. Members of the Philosophy Department at York had heard Professor Millican's account of the new Oxford degree, and members of both the

Philosophy Department and the Computer Science Department had been impressed by the associated research on his website. They were persuaded that there would be considerable interest in a degree at York that combined the two disciplines, and such a degree was established in 2012. Professor Tom Stoneham, Head of the Philosophy Department, has said that he is happy to corroborate this account.[4]

5. Sources to corroborate the impact (indicative maximum of 10 references)

Testimonials
[1] Statement from Oxfordshire Computing in Schools Coordinator

[2] Statement from Headmistress, Westfields Junior School (Yateley)

[3] Statement from Ofsted National Lead

[4] Corroboration of general impact on higher education available from Head of Philosophy, University of York

Other Evidence Sources
[i] The book by Frederick Burwick and James C. McKusick in which they make use of *Signature* is *Faustus: From the German of Goethe: Translated by Samuel Taylor Coleridge* (Oxford University Press, 2007).

[ii] The page on the website of *Friends of Coleridge* devoted to Burwick and McKusick's claim about Coleridge's translation of *Faustus* is http://www.friendsofcoleridge.com/Faustus.htm.

[iii] Professor Millican's *Sunday Times* article, which was published on 2 November 2008, is reproduced at http://www.philocomp.net/humanities/dreams.

[iv] Details of Professor Millican's exposure of J.K. Rowling as the author of *The Cuckoo's Calling* can be found at: http://www.leakynews.com/jkrowling-new-book-pseudonym-crime-novel-robert-galbraith.

[v] Craig Kolb refers to his work with Professor Millican in the following article: http://www.bizcommunity.com/Article/196/424/87920.html.