Institution: University of Sussex

Unit of Assessment: UoA 11 – Computer Science and Informatics

1. Context

Our research is in the areas of artificial intelligence, digital economy, digital media, human-computer interaction, software systems and the theory of computation. In this research we have developed algorithms and data-modelling techniques that provide more accurate extraction of information from unstructured and semi-structured data, improved ways of transmitting, interpreting and presenting data, better ways of understanding how living organisms process and act on information, and new ways of making connections between diverse kinds of information.

Non-academic beneficiaries of our research include innovative technology-oriented computing companies; these are either start-ups developing improved technology in competition with an established market leader, or companies operating in niche markets for which there is no appropriate existing technology. Other beneficiaries are companies and non-profit organisations seeking to use information technology to automate business processes and to reach out to their customers in new ways. Further impacts are social and cultural, including engagement with schools and the general public to stimulate interest in and understanding of science, and technology supporting the public's awareness and understanding of their cultural heritage and aiding the social regeneration of communities.

In addition to these areas of impact (two examples of which are presented in the case studies), we are making good progress in developing further impacts in the areas of social policy, environment and health (as indicated briefly in Sections 2 and 3 below).

2. Approach to impact

We recognise four main factors that are necessary for achieving impact from our research:

- establishing relationships with potential non-academic beneficiaries;
- securing resources and funding to support the development of impact;
- protecting intellectual property that we have created; and
- training, supporting and rewarding staff who carry out impact-related activities.

We use a number of methods to **establish relationships with non-academic beneficiaries** with the objective of achieving impact. We give four methods with illustrative examples below.

- Broaden training-based partnerships: each year since 2004, American Express has sponsored 12 of their employees to study part-time for an MSc in technology innovation or computing in our Department. A core area of training is digital economy technologies and, in 2011, we set ourselves the goal of adding applied research to the partnership and achieving impact in that area; in 2012 we made progress towards this goal by jointly securing a £1.5m Technology Strategy Board grant.
- Extend educational collaborations: a number of companies propose BSc and MSc student projects; in 2010, one such project developed an innovative software tool for indexing web documents by keywords. The success of this project led to the company funding applied research contracts worth £135k to develop proof-of-concept systems in order to raise venture capital to fund further development.
- Participate in industry/academia networks: the University and the London Technology Network jointly sponsored a senior member of academic staff to be a 'Business Fellow', 2006–11. The Fellow presented posters and gave talks at more than a dozen computing- and IT-related networking events. These events generated many 'leads' for potential partners, one of which led to a Technology Strategy Board grant with two SMEs, resulting in technology transfer and

anticipated impact in the area of text analytics.

- Engage with University-led networking events: the University's Research and Enterprise Division organises academia/business networking events on cross-sector topics (such as 'Crowds and Communities'), and also with specific organisations (e.g. American Express and Brighton and Hove Albion Football Club, whose stadium they sponsor). Discussions at such events led to a successful bid with the club to an EPSRC 'Research in the Wild' call.

Having identified and developed relationships with potential non-academic beneficiaries, we **secure resources and funding to support the development of impact**. We use a range of mechanisms, from those that typically deliver impacts in the short term to those that are long-term, depending on how far the research is from application:

- Consultancies, for example advising museums (as in the 'Augmented Digital Representations' case study) on the design and implementation of cultural heritage installations – applying to a commercial problem our research on 3D visualisation and augmented reality.
- User-funded contracts, for example a £100k subcontract from the Institute of Development Studies (an autonomous unit located on the Sussex campus) to apply research into computer-based 'serious games' to train small-scale farmers in Africa in food production and pricing strategy – with anticipated environment-related impact.
- Internally funded pump-priming, for example using a budget allocation from the Higher Education Innovation Fund (HEIF) to fund collaboration between one of our research fellows and the Clinical Practice Research Datalink (CPRD); CPRD are now funding this themselves since it will allow randomised controlled trials to be carried out retrospectively over high-quality information in patient records – with anticipated health-related impact.
- Knowledge Transfer Partnerships, such as applying human reaction-time measurement technology in mobile apps in order to test cognitive affect, in collaboration with food and appetite psychologists at Sussex, and Leatherhead Food Research.
- Spin-outs and early-stage trading ventures, with internal support ranging from advice on drafting a business plan (as in the 'Automatic Grammatical Analysis' case study), to providing substantial start-up funds for equipment (for new kinds of computer-game usability-testing) from the University's Enterprise Development Fund (through HEIF), with hosting and mentoring by the Sussex Innovation Centre (an on-campus business incubator).
- Technology Strategy Board (TSB) projects, funded through recent calls in 'Creative Industries: Application of Digital Technologies', 'Harnessing Large and Diverse Data Sources', and 'Collaboration Across Digital Industries: Creating Sustainable Value Chains'.
- UK Research Council and EU projects, for example via calls such as the EPSRC's 'Research in the Wild', through which we have demonstrated the feasibility of sharing smartphone bandwidth, allowing thousands of people in a crowd to establish data connections.
- UK Research Council public understanding of science projects, for example 'Walking with Robots', which made contact with 80,000 people; this impact was recognised by the award of the Rooke Medal for the Public Promotion of Engineering from The Royal Academy of Engineering. We used sponsorship for the 2012 Annual Meeting of the Association for the Scientific Study of Consciousness to organise an associated public exposition, which attracted 1,000 members of the general public.

We seek to **protect intellectual property** that we have created and which may be used to support impact. For example, the University's Enterprise Development Fund has funded patent applications in relevant regions of the world for our technology for sharing smartphone bandwidth.

The final element of our approach is to **train, support and reward academic staff** for achieving impact. We have sent staff on courses organised by the London Technology Network, covering topics such as how to interact with companies, and ways in which technology is transferred from academia to business. The Department supports staff in strategic collaborations with companies (as in the CPRD example, above). At most annual Departmental research away-days, technology transfer officers from the University's Research and Enterprise Division have given presentations

on opportunities for funding for applied research and technology transfer, and members of academic staff have shared their experiences of such activities.

The University recognises the value of consultancies in supporting impact, and so, for consultancy activity facilitated and recorded by the University, members of staff have the option of taking 85% of the fee as salary or using it to support their research. Excellent performance in achieving impact is recognised through promotion and salary bonuses; for example in 2012–13, public and business engagement formed significant parts of two successful cases for promotion in the department.

3. Strategy and plans

Our strategy for achieving impact is based on the University's strategy for 'Business and Community', which aims to 'ensure that our key academic achievements have practical applications, such as products and services, which benefit the wider community'. The (School-level) Director of Research and Knowledge Exchange, the Head of School and the Head of the Department of Informatics (which is coterminous with this REF submission) are responsible for implementing this strategy at Department level by establishing goals and policies, and ensuring that appropriate support is available. Strategy is triangulated against the external context through a Strategic Advisory Board, which meets twice yearly; the Board is chaired by the Director of Global Research at Arup, and includes leading industrialists and research commissioners.

Each of the four research groups in the Department sets its research and impact goals, prioritised in consultation with the Head of Department; the group leader then plans activity accordingly. The baseline expectation is that each group will carry out excellent basic research and – where the nature of the research allows – use the approaches outlined in Section 2 to maximise its impact. Beyond this, from 2013, group-specific goals relating to impact include the creation of a spin-out to commercialise delay tolerant network research, and the establishment of a collaboration with social scientists to achieve policy impact from social media text-mining research.

Department policy is adjusted to take account of new circumstances and opportunities for increasing impact. For example, in 2011, policy was changed such that the Department now commits to co-sponsor PhD students contributing to user-funded contracts in situations that provide suitable research training and build capacity for impact. The text analytics research lab has leveraged this co-sponsorship to secure such contracts worth £600k.

Within the Department, support for maximising impact is coordinated by a senior member of academic staff, who is responsible for industry liaison and who responds to and passes on technology requests, tracks beneficiaries and impacts, and mediates external interactions if necessary. This substantial role (which is recognised in workload planning) includes initiating engagement opportunities, such as organising Department-wide open days at which research is presented to industry invitees.

4. Relationship to case studies

In REF3b we present two case studies that achieve impacts through three types of non-academic beneficiary mentioned in Section 1 above: innovative technology-oriented computing companies, companies and non-profit organisations that make extensive use of information technology, and communities and sections of the general public.

In the 'Automatic Grammatical Analysis' case study, a spin-out from the University is applying research in the syntactic analysis of English to automate business processes and to contribute to improved technology. The company took advantage of University support during start-up (as outlined in Section 2), and achieves impacts through user-funded contracts (again, see Section 2).

In the 'Augmented Digital Representations of Cultural Heritage' case study, collaborations with non-academic organisations are supported by funding from consultancies, and RCUK and EU projects (see Section 2); the beneficiaries are museums and sections of the general public, with impacts occurring through people's digital interactions with their cultural heritage.