Institution: Aston University

Unit of Assessment 11: Computer Science and Informatics

a. Context

The two research groups in this UOA provide solutions to the challenges of large and multilevel datasets and complex systems: the **Non-linearity and Complexity Research Group (NCRG)** focuses on probabilistic pattern analysis and the analysis of complex systems; the **Computer Science Research Group (CSRG)**, develops novel algorithms in computational intelligence, software engineering, visual information processing, health informatics and cognitive science.

Beneficiaries

The majority of the non-academic users of the unit's research are businesses of all sizes in engineering and ICT sectors that use the advanced techniques and methodologies from the unit to solve their problems and to incorporate into their products. Our research in health informatics benefits the NHS, private, and third-sector healthcare providers.

Types of Impact

The types of impact have been primarily on the **economy**, **health**, and **practitioners**, with more indirect impact on the **environment** and **policy** and relate to both research groups. The routes included direct deployment of systems developed by Aston, support for the development of new products, consultancy to improve existing products, open-source software, and less direct impacts on the economy (e.g. additional sales, employment etc.) and policy (particularly the environment).

b. Approach to impact

This unit mainly carries out principled applied research, most often in collaboration with end users: impact is at the heart of its research strategy. It focuses on domains with large amounts of data, complex systems and uncertainty, and builds on accumulated expertise to achieve greater depth in specific domains.

1. User interactions and relationships

The UOA uses a broad portfolio of mechanisms to collaborate flexibly with industry and the public sector. The collaboration method is chosen according to the stage of the collaboration, the scale and complexity of the project, and the need for IP protection. Of the c. 25 staff in this UOA, 22 have carried out funded collaborative work with companies.

Professional networks and Advisory Boards. The NCRG has cultivated close links with scientific/industrial networks such as the Natural Computing Applications Forum: *Nabney* is the current Chair. Members of the UOA sit on advisory boards for industrial organisations. Technical Forecast Ltd. (*Lowe*); Birmingham Science Park Aston (BSPA) (*Nabney*); mentoring start-up accelerator programmes (*Bastin*, *Nabney*). This has helped to develop close relationships with several companies at BSPA (IGI Ltd, Majestic-12, Daden: see Visual Analytics case study).

Public engagement and knowledge exchange. The UOA contributed strongly to the British Science Festival at Aston in 2010. Five events were organised: one, on the danger of texting while walking (*Lumsden*), was the fifth most widely publicised event at the Festival with over 30 articles and interviews (including the BBC World Service and the New York Daily News). *Little* was a TED Fellow in 2012. *Buckingham* has presented to mental-health organisations and service providers about 100 times (see GRiST case study), leading to 3 EPSRC CASE studentships. *Robert Matthews*, Visiting Reader in the NCRG, is a science journalist who has contributed to Aston research projects in health informatics.

Industrial Training. The NCRG has run several short courses on topics in pattern analysis (including 3 workshops specifically designed for BAE Systems), using Netlab to provide hands-on experience of the algorithms in practice and thus increase the use of our research by practitioners. GRiST training sessions have been delivered by the team and independent companies.

2. Follow-through to impact

The main domains of impact from the NCRG are in: **biomedical information engineering** e.g. Pfizer (quality control for high-throughput screening); **signal processing** e.g. Thales Underwater Systems Ltd (sonar) and Cardionetics (ECG); **risk analysis** e.g. Rolls-Royce (reliability impact of design); **condition monitoring** e.g. Agusta Westland (helicopter airframes); **environmental modelling** e.g. IGI Ltd and the Met. Office (data quality); **communication and power networks** e.g. Alstom Grid Ltd (smart-grids). Key beneficiaries for the CSRG include: **health informatics and decision support** e.g. NHS (GRiST); **geographic information systems and web services** e.g. FERA (UncertML case study); **Human-Computer Interaction** e.g. Daden (Visual Analytics case study); **computer vision** e.g. Activision/Blizzard (US) and 3D Flow (Italy) (creation of photo-

realistic assets: e.g. 'Call of Duty' computer game). As an example of the scope of impact, the GRiST system has been used for 285,000 risk assessments for 52,000 patients.
Commercialisation. Researchers are encouraged to pursue the protection of IP and supported in the formation of spin-out companies or licensing of intellectual property. Although patents are not so important in this domain (since algorithms are not directly patentable), four have been awarded: digital watermarking, molecular property prediction, and two in telecom networks.
Co-funded research. Since 2008, there have been 7 KTPs (£864k) and 9 CASE studentships (£720k) and 1 TSB project (£120k). In addition to delivering impact directly, these projects have also helped staff to develop long-term partnerships with companies which encourages greater sharing of knowledge and the creation of spin-off projects (e.g. Pfizer).
Business Assists for CDE, Pfizer, EOn, Select Research, Majestic-12, WheelRight, Activision. These projects (value c. £80k) came from a direct approach by each company to solve an important business problem. Aston University led the development of INDEX innovation vouchers funded by ERDF and Advantage West Midlands – up to £3k of academic consultancy. The UOA led 15 business assists through this scheme. ERDF funding is supporting the TouchDigital project delivering 20 business assists from Aston in human interaction technologies.
European Networks. EU Framework Programme projects involving users have provided opportunities for impact outside of the UK: Biopattern; UncertWeb (Food and Environment Research Agency; Norwegian Institute for Air Research); INTAMAP; GeoViQua (52°North Initiative for Geospatial Open Source Software GmbH; Commissariat a l'Energie Atomique; European Space Agency; Open Geospatial Consortium Europe; Science and Technology Corporation, Holland); ADVANCE (Technology Transfer System srl, Italy; Palletways).

3. Agile approach to opportunities

In the early stages of engagement, exploratory studies are the most appropriate: standard contracts and expertise in funding mechanisms allows us to respond quickly to user need. These can be sponsored MSc projects, innovation vouchers, or consultancy. Once the research is proven in the company's context, the scale of the project increases: e.g. CASE studentships; PDRAs or EU projects for larger challenges. Finally, KTP and TSB projects have been used to transfer research into commercial systems. A good example is the collaboration with Pfizer Central Research. This started with two Research MSc students working on quality control in high-throughput screening. Next was a BBSRC-funded PDRA project in bioinformatics on which Pfizer funded a PhD student. Then Pfizer fully funded an overseas student who developed the Data Visualisation and Modelling Systems (DVMS) and co-funded a BBSRC CASE studentship.

4. Unit support for staff

The UOA has strategically recruited academic staff with strengths in applicable research. External engagement is explicitly recognised through awards and as a promotion criterion. The UOA provides directed support for all staff, particularly ECRs, to build impact: start-up funds and PhD students; monitoring and reviewing research and impact plans; co-supervision of students; collaboration with experienced staff on industrial projects to develop skills in industrial interaction (e.g. KTPs (*Konecny*, *van Mourik*, *Wong*), consultancy (*Lumsden*)); leave or reduced hours for Fellowships (*Bastin*) and industrial leadership (*Cornford*).

5. Institutional Resources

Research support teams increase range and depth of industrial contacts relevant to our research, broaden partnerships with European companies and extend health informatics activity deeper into the NHS. The Business Partnership Unit **(BPU)** supports researchers to transfer knowledge to businesses and other organisations. It provides support for successful exploitation and impact of research; helping to organise industrial events and targeted marketing material for business; and managing the IP portfolio and supporting commercialisation activity. The Research Support Office **(RSO)** helps staff to access research funding, including briefing sessions on funding that relate a general approach to successful applications. Aston Health Research and Innovation Cluster **(AHRIC)** co-ordinates health-related research and innovation and develops strategic relationships with NHS Trusts, SHAs and universities.
Business Development Managers work with academics to identify external organisations and generate projects that are either collaboratively or fully funded. These partnerships are sourced through directed marketing, networking events and exploitation of existing links. This service is particularly valuable for ECRs. The BPU has particular expertise in KTP, CASE and EU Framework funding, delivering a total value (to the UOA) of £1,267k of research grants involving

funding from industry, commerce and the public services.

6. Other mechanisms

Aston Active Software Engineering is a University student software development "company" that carries out development tasks on projects. Interns have helped academic staff build publicly accessible demonstrators. This has helped cross the gulf between Technology Readiness Levels 1-3 to 6 and upwards and is encouraging for industry to undertake further development.

Open-source software. Public open-source software is a powerful mechanism for impacting on practitioners: academic users are often from other disciplines and apply the software: e.g., financial forecasting, clinical diagnostics, flood modelling. We can measure impact through the number of downloads: the Netlab pattern analysis toolbox has been accessed more than 40,000 times. Other public software includes: AERN libraries for arbitrary-precision computation; DVMS (Visual Analytics case study) and milva visualisation tools; UncertML and associated web tools (UncertML case study); ADVANCE (predictive analytics and decision support for logistics); eGRiST.

c. Strategy and plans

A major strength of the UOA is that it has always championed a principled approach to the real-world use of computer science, mathematical and cross-disciplinary approaches to information and data management and analysis, working in collaboration with end-users, business, commerce and government bodies at national and international levels. Our strategy is to build on this strength, to enhance engagement with users and beneficiaries of our research, and to develop this network for the improved education and training of research scientists who will apply these skills in society. Therefore, our plan is to a) empower staff and research graduates, b) enhance user engagement and c) exploit research directly. Six-monthly reviews of the research portfolio will enable us to identify key research innovations that will be of value to end users b) or for exploitation c).

a) *Empowered Staff and Students:* We will create a Doctoral Training Institute (DTI) in Big Systems Analytics in 2014 which engages with existing and new businesses (more than 20 companies have already expressed an interest in being involved). Staff will be incentivised through the inclusion of impact as a specific criterion for recognition and promotion in the University, and awareness of our research associates and students of the value of impact will be developed through involvement in the e4f incubator at BSPA as part of their training. Funding from the EU (Marie Curie and ERDF) will be sought during 2014 to supplement direct industrial sponsorship. All students will carry out at least one industrial project during their PhD (on the short KTP model). Our goal is to maintain a cohort of at least ten students per year in a rich, industrially integrated, international, and principled research training programme.

b) Enhanced User Engagement: Additional to direct user engagement in our programme through our DTI advisory group, the UOA will develop and deliver additional regular user-focussed technology workshops and data analytics training programmes in collaboration with the BPU to develop productive relationships with a wider group of companies; carry out small-scale and prototype investigations for industry through the DTI; use ERDF business assists, TSB directed calls and KTPs to be more responsive to smaller business needs. A technology blog and newsletters (distributed by the BPU) will increase understanding of the impact of the UOA's research through the business community: we shall engage with at least 8 new partners each year.

c) Directed Impact Portfolio: The UOA has historically relied upon projects that collaborate directly with industry to exploit intellectual property. To complement this strategy, we shall take a longer-term view of the research portfolio and directly exploit IP through spin-out companies (building on our close relationship with BSPA) and licensing. Staff from Aston Business School will provide expert guidance on business functions such as strategy and marketing. Impact pathways will be developed from project conception and actively managed with the help of the BPU. Areas which are immediately ready for this approach include GRiST, data visualisation, and computer vision model development. Income from these activities will be reinvested in the Institute. The goal is to create at least one spin-out or large licensing deal each year.

d. Relationship to case studies

The Visual Analytics case study demonstrates our agile approach to creating impact and the leverage of a research advance across several application domains and organisations. The GRiST case study is a good example of breadth of user engagement and depth of follow-through. The UncertML case study shows how open-source software and training materials are provided *pro bono* to broaden the user base and create a wide range of impacts in the policy and public sectors.