

UoE cover sheet and summary

Institution:	University of Edinburgh	Institute/ Group Name:	University of Edinburgh ICT summary and totals		
Main Contact:	Prof Michael P Fourman	Institute/ Group Size			
Group webpage: http://www.ed.ac.uk/		Academic Researchers	322	Academic Staff	133
		PG Students	318		

Strategic Vision Statement (200 words max.):

The University of Edinburgh has a broad-ranging community of research in ICT. The systems we study include hardware, software, wetware, and people. Our interests range from conceptual and mathematical foundations to innovation, application and exploitation. We interact with almost every other area of the University, from Music to Medicine, from Management to Mathematics. The core of this activity is centred around the School of Informatics, and the School of Engineering and Electronics. This return includes these, and also describes the work of the Edinburgh Parallel Computing Centre, the Institute for e-Science, the Centre for Speech Technology Research, and the Edinburgh Centre for Bioinformatics.

These all contribute to the foundations and applications of a new science of information, *Informatics*: the study of systems, both natural and artificial, that sense, store, process, communicate, and act on information.

Our mission is comparable to that of other sciences

- To increase the understanding and exploitation of the fundamental properties of systems, that sense, store, process and communicate information - through leading edge research and innovation.
- To enhance the excellence of the research base by supporting a high quality portfolio of research and postgraduate training.
- To support a pool of talented researchers at all stages of their careers.
- To enhance the performance of other disciplines and user communities through the provision of knowledge and trained personnel.

The School of Informatics supports a broad portfolio of research and training in the areas of: Foundations of Computer Science; Computing Systems Architectures; Adaptive and Neural Computation; Intelligent Systems and their Applications; Communicating and Collaborative Systems; Perception Action and Behaviour; Speech Technology is a collaborative activity with the School of Philosophy, Psychology and Language Sciences; Digital Communications, and Integrated Micro and Nano Systems research is centred within the School of Engineering and Electronics; the Edinburgh Parallel Computing Centre and the Institute for e-Science fall within the School of Physics.

Research Themes (provide a brief summary title for each theme and give the key lead contact(s)):

Separate, individual data sheets are attached for each of the following (total funding shown in brackets):

- **Informatics Graduate School (£8M)**
- **Centre for intelligent Systems & Applications (£3.3M)**
- **Institute for Computer Systems Architectures (£8.84M)**
- **Laboratory for Foundations of Computer Science (£7.7M)**
- **Institute for Communicating and Collaborative Systems (£13.6M)**
- **Institute for Adaptive and Neural Computation (£2.1M)**
- **Centre for Speech Technology Research (£5.9M)**
- **Institute for Perception, Action and Behaviour (£6.2M)**
- **Prospekt Commercialisation (£8.2M)**
- **Edinburgh Centre for Bioinformatics (£61M – of which £30.5M is ICT-related)**
- **Edinburgh Parallel Computing Centre (£13.6M)**
- **Institute for e-Science (£9.6M)**
- **Institute for Digital Communications (£12.5M)**
- **Integrated Micro and Nano Systems (£7.12M)**

Overall total research funding: £137.2M

In addition, a new building to house Informatics research is being constructed (opening August 2007) at a cost of £42M and EPCC run the HPCx Research Contract : £54.6M

DATA SHEET:

Institution:	University of Edinburgh	Institute/ Group Name:	Informatics Graduate School		
Main Contact:	Prof Don Sannella, Director	Institute/ Group Size	N/A		
Group webpage inf.ed.ac.uk/postgraduate		Academic Researchers	N/A	Academic Staff	N/A
		PG Students	250		

Strategic Vision Statement (200 words max.):

Graduate School exists to ensure quality and consistency of graduate supervision and training, to build a postgraduate community, coordinate recruitment and publicity, and develop and coordinate postgraduate taught courses.

Graduate Student Research Training (Please provide brief details of type of training provided, including current numbers of students as well as the typical number of advanced degrees (MPhil & DPhil) awarded annually):

The School of Informatics currently has 250 students studying for PhD, 6 students studying for MPhil, and 15 students studying for MSc by Research. (Most of these 15 are in the first year of the Neuroinformatics DTC, see below.)

Application numbers are bouyant with 361 applications in 2005/2006. Funding is provided from a wide variety of sources, with about 90% of PhD students receiving at least partial funding during their first 3 years of study.

Each incoming student is allocated to one of 6 research institutes where they are provided with office space and research facilities. Supervision is by a member of teaching staff from that institute and one or more assistant supervisors. When the research straddles discipline boundaries, supervision is by two equal co-supervisors, one in Informatics and one in another School.

First-year PhD students in LFCS spend part of their time on a programme of courses and seminars covering advanced material in Theoretical Computer Science. Other first-year students are required by their supervisors to attend MSc courses that are relevant to their planned topic of research. None of these courses are formal requirements for completion of PhD study. Transferable skills courses are available with topics such as Effective Presentations, Time Management, etc.

Progress towards successful completion is formally reviewed annually by a panel which includes colleagues who are independent of the supervisory team, using a written progress report as input. The officially-allocated time to completion is 3 years, which is very low by international standards. Because Edinburgh PhD students tend to tackle world-class problems, average time to completion is close to 4 years.

Some PhD students and MSc by Research students study under the Neuroinformatics Doctoral Training Centre, a "1+3" PhD programme funded by the LifeSciences interface of the EPSRC and the MRC. The programme was started in

2002 and will be subject to renewal in 2007. After an MSc year devoted to training in Informatics and Neuroscience, the students choose a PhD project in an interdisciplinary topic. Co-supervisors of these projects include staff from Neuroscience, Psychology and Electrical Engineering at the University of Edinburgh. Outside Edinburgh, collaborations exist with Stirling Univ, St. Andrews, Cambridge, and Sheffield. Typical projects include image analysis for MRI, neurorobotics, map formation in the cortex, VLSI chips of neural circuits, neural computational models of vision and memory. The students have access to their own seminar series, business contacts and a tailored transferable skills programme.

The Institute for System Level Integration (ISLI) is a collaborative venture between 4 Scottish HEIs. It provides Masters level; courses and an SPSRC-funded Engineering Doctorate programme, administered from Glasgow: there are 2 Informatics EngD students (in addition to the two reported in the IDCOM datasheet).

On average, 25-30 PhD students graduate per year (at present), with about 10 of these from the NeuroInformatics DTC. These numbers do not reflect the increasing PhD student intake over the past few years and, consequently, will be expected to rise significantly. (recent intake 04/05: 63, 05/06: 65, 06/07: 70).

Funding ('Current' Research Income, including sources):

Doctoral Training Centre (EPSRC/MRC)	£5,760,393
Doctoral Training Account	£2,270,000

Additional students are funded directly from research grant and contract income which is reported in the relevant research institute data sheet.

DATA SHEET:

Institution:	Informatics	Institute/ Group Name:	CISA		
Main Contact:	Dave Robertson	Institute/ Group Size			
Group webpage www.cisa.informatics.ed.ac.uk	Academic Researchers	11	Academic Staff	6	
	PG Students	38			

Strategic Vision Statement (200 words max.):

CISA undertakes basic and applied research and development in knowledge representation and reasoning. Through its Artificial Intelligence Applications Institute (AIAI) it works with others to deploy the technologies associated with this research. Much of our current research focuses on reasoning, knowledge sharing and action in heterogeneous, asynchronous and distributed environments.

Research Themes (provide a brief summary title for each theme and give the key lead contact(s)):

- Mathematical reasoning (Alan Bundy)
- Intelligent systems for emergency response (Austin Tate - AIAI)
- Multi-agent learning (Michael Rovatsos)
- Knowledge sharing in open, distributed systems (Dave Robertson)

Key Research Highlights over last 5 years (these might include journal papers, awards, patents, spinout activity, etc. Please be selective, if necessary choose the top 10):

- Bundy won two of the three most prestigious awards in AI: the IJCAI Distinguished Service Award (2003) and the IJCAI Research Excellence Award. Maths Reasoning Group invented and developed the reasoning techniques of proof planning and rippling, which are now standard topics in calls for papers at automated reasoning conferences.
- Maths Reasoning Group were awarded an EPSRC Platform Grant GR/S01771 "The Integration and Interaction of Multiple Mathematical Reasoning Processes" in October 2002, which will be renewed for four more years wef April 2007. This is a multi-site collaboration with Heriot-Watt, Liverpool (was Nottingham) and Imperial.
- Numerous spinoff companies, including Pocketwatch, Mobaitec, I-C2 Systems and Level E.
- Books charting key areas of our research, for example: Bundy et.al. "Rippling: meta-level guidance for mathematical reasoning" Cambridge University Press 2005, Walton, "Agency and the Semantic Web", Oxford University Press, 2006.
- Consistent record of publication across the range of high quality theoretical and applied journals in our area, for example: Journal of Automated Reasoning, Annals of Mathematics and Artificial Intelligence, Engineering

Applications of Artificial Intelligence, Journal of Networks and Computer Applications, IEEE Intelligent Systems.

- Consistent record of presentation at the most prestigious international conferences in our area, for example: IJCAI, AAI, ECAI, CADE.

Graduate Student Research Training:

See School of Informatics submission.

Funding ('Current' Research Income , including sources):

Current research grant portfolio: £3.3M

EPSRC: £2M

EU £665K

Other £645K

Key Collaborators: Academic and non academic, including overseas:

Austin Tate, as part of his "Helpful Environment" and intelligent systems work in emergency response, interacts with a large number of groups and standards organisations worldwide in the UK and the rest of Europe, in the US and beyond. His main collaborators are industrial, academic and government lab researchers on various DARPA funded programmes in the USA, along with the AKT IRC (UK) and OpenKnowledge (Europe) emergency response challenge team members. He is also involved in transfer of the relevant technologies through joint projects with industry in the UK, France, US, and has set up a spin out company to promote the use of the systems, I-C2 Systems Ltd.

Co-investigators on the MRG Platform Grant (GR/S01771) are Ireland & Georgieva (Heriot Watt), Colton (Imperial), Dennis (Liverpool). On other MRG grants grant we have Smith (Glasgow, Maths) on GR/S31099 and Anderson/Bond/Clulow (Cambridge), Cortier (CNRS & INRIA, Nancy) nCipher plc, Korala Associates and CESG (information assurance arm of GCHQ) on GR/S98139. Main overseas collaborators are Siekmann's group at Saarbrucken, including Hutter, Autexier, Benzmueller, Melis, etc. Others are Armando (Genoa), Walther (Darmstadt), Kerber & Sorge (Birmingham), Paulson and Jamnik (Cambridge).

Co-investigators on the OpenKnowledge grant are van Harmelen (Amsterdam), Sierra (Barcelona), Motta (Open University), Shadbolt (Southampton) and Giunchiglia (Trento).

Co-investigators on the AKT IRC are Sleeman (Aberdeen), Motta (Open University), Wilks (Sheffield) and Shadbolt (Southampton).

Key collaborators on Rovatsos' multi-agent research are : Rahwan (Dubai), Pechoucek/Tozicka (Prague), Fischer (University of Munich), Nickles (Technical University of Munich), Weiss (SCCH Linz/Austria), Lluch (Microart SA Barcelona)

DATA SHEET:

Institution:	School of Informatics	Institute/ Group Name:	ICSA		
Main Contact:	Prof Nigel Topham	Institute/ Group Size	63 (inc. visitors and associates)		
Group webpage www.inf.ed.ac.uk/research/icsa		Academic Researchers	20	Academic Staff	8
		PG Students	30		

Strategic Vision Statement (200 words max.):

The Institute for Computing Systems Architecture (ICSA) is primarily concerned with the architecture and engineering of future computing systems. Its fundamental research aims are: to extend the understanding of the performance and scalability of existing computational systems; to improve the characteristics of current systems through innovations in algorithms, architectures, compilers, languages and protocols; to develop new and novel architectures and to develop new engineering methods by which future systems can be created and maintained.

Research Themes (provide a brief summary title for each theme and give the key lead contact(s)):

In ICSA there are 7 research themes. These cover the spectrum from hardware design to the design of optimising compilers, as well as system-level design issues in mobile sensor networks and network protocols. There is a strong synergy between the themes in compilers, architectures and micro-architectures, with close cooperation between the researchers in these themes through the informal Compilers and Architectures group.

- Compilers (Prof Mike O'Boyle)
- Mobile Sensor Networks and "Speckled Computing" (Mr D.K. Arvind)
- Parallel Languages (Dr Murray Cole)
- Micro-architecture and Automated Synthesis (Prof Nigel Topham)
- Parallel Architectures (Dr Marcelo Cintra)
- Hardware Design Automation (Dr. Aris Efthymiou)
- Embedded Systems and Design Space Exploration (Dr Bjoern Franke)
- Networking and communications (Dr Mahesh Marina – recently appointed)

Key Research Highlights over last 5 years (these might include journal papers, awards, patents, spinout activity, etc. Please be selective, if necessary choose the top 10):

- The award for Best Presentation was given to the following paper from the compiler and architecture group in ICSA (with IANC and others):
F Agakov, E Bonilla, J Cavazos, G Fursin, B Franke, M.F.P. O'Boyle, M Toussant, J Thomson, C Williams **Using machine learning to focus iterative optimization**, ACM Code

Generations and Optimization, New York, March 2006.

- The award for Best New Product was given at GSPx (Santa Clara, 2005) to the **SIMD Media Processor** architecture developed by Prof. Topham in a collaborative research project with ARC International (UK) Ltd.
- ICSA submitted the highest ranked paper out of 162 submissions to PACT 2003, with:
 - B. Franke, M. F.P. O'Boyle, **Combining Program Recovery, Auto-parallelisation and Locality Analysis for C programs on Multi-processor Embedded Systems**, IEEE PACT 2003.
- ICSA submitted the highest ranked paper out of 95 submissions to HiPEAC conference Barcelona 2005, with:
 - Grigori Fursin, Albert Cohen, Michael F.P. O'Boyle, and Oliver Temam, **A Practical Method For Quickly Evaluating Program Optimizations** Proceedings of the 1st International Conference on High Performance Embedded Architectures & Compilers (HiPEAC 2005), pages 29-46 (LNCS 3793), November 2005.
- The award for Best Paper was given to the following ICSA publication:
 - W. Maruringsith and R.N. Ibbett, **Dsimcluster: A Simulation Model for Efficient Memory Analysis Experiments of DSM Clusters**, Summer Computer Simulation Conference, San Jose, CA, July 2004.
- The Speckled computing consortium has been successful in attracting in excess of £5M funding from EPSRC and Shefc during the past 3 years.
- The Speckled computing group leader, D.K. Arvind, was invited to speak at Nanotech 2005, Anaheim CA, USA, May 2005.
- The micro-architecture group leader, Prof Topham, submitted his most recent patent on high speed computer simulation techniques in October 2006. In the period May 2004 to October 2006, he was granted 7 US patents and filed a further 4 US patents.
- The Skeletal parallelism paradigm, developed by Dr Murray Cole, is now used by 30 research groups across the globe. Software tools developed under EPSRC projects are disseminated to these groups, stimulating further research in this area.

Graduate Student Research Training (Please provide brief details of type of training provided, including current numbers of students as well as the typical number of advanced degrees (MPhil & DPhil) awarded annually):

There are currently 30 registered PhD students in ICSA, with approximately 6 students graduating annually.

We also have 2 EngD students working with Prof Topham and Dr Efthymiou on projects sponsored by ARM Ltd (Cambridge) and Critical Blue Ltd (Edinburgh). These students' EPSRC support is administered via the Glasgow University and ISLI EngD.

Funding ('Current' Research Income , including sources):

Current research grant portfolio for ICSA totals £8.84 million. This is sourced as follows:

EPSRC grants	£5,649,233	(7 active projects)
EU projects	£1,716,949	(3 active projects)
Shefc grants	£1,322,186	(1 active project)
Industry	£ 152,565	(2 active projects)

Key Collaborators: Academic and non academic, including overseas:

ICSA is the UK coordinator of the EU HiPEAC network of excellence in high performance embedded architectures and compilers. Through this network we collaborate with a wide range of European researchers. The primary academic collaborators in these areas are: UPC Barcelona (Profs Gonzalez and Valero), INRIA (Prof Temam), University of Aachen (Prof Leupers). The compiler and architecture group has industry collaborations with ARC International (UK) Ltd, IBM (Haifa, Israel) and CAPS Entreprise (France).

- The micro-architecture group collaborates closely with industry partners, including ARC International (UK) Ltd and ACE (Holland).
- A small research activity in Storage Area Networks is currently being carried out in collaboration with Xyratex (UK), to model and predict performance levels in highly parallel RAID systems.
- The Speckled computing research group leads a consortium of Scottish universities including: Glasgow, Strathclyde, St. Andrews and Napier University.
- Dr Efthymiou's research group in asynchronous hardware design is collaborating with the universities of Manchester and Newcastle in a joint EPSRC project. This also includes UK industry partners Silistix and FTL Systems.
- The structured parallelism group collaborates with former Edinburgh researcher staff now in an academic position at the Ecole Normale Superieure de Lyon, as well as with academics in LFCS.

The parallel architectures group collaborates with researchers at the University of Valladolid, Spain.

DATA SHEET:

Institution:	The University of Edinburgh	Institute/ Group Name:	LFCS		
Main Contact:	Dr Julian Bradfield	Institute/ Group Size			
Group webpage http://www.inf.ed.ac.uk/research/lfcs	Academic Researchers	17	Academic Staff	22	
	PG Students	40			

Strategic Vision Statement (200 words max.):

The mainspring of research in LFCS is the study of theories which underlie, or should in future underlie, the modelling, analysis and design of natural and artificial computational systems ie Informatics. Many theories are under present study: theories for general semantics, for concurrent and stochastic systems, for system specification, for programming language design, for databases, for algorithms, and theories of general logic. Theory-based modelling is applied to computational systems ranging from hardware to biological systems. In most of these cases, a significant software tool has been or is being built to mediate the theory to applied computer scientists, including industrial scientists.

The work of the LFCS has a core of theoretical research and a practical component which explores application and implementation of the theory. It is unified by a common culture, grounded in the conviction that a solid mathematical understanding of computation and communication is an essential foundation for robust and correct computational tools and artefacts.

Research Themes (provide a brief summary title for each theme and give the key lead contact(s)):

Foundational semantics (Gordon Plotkin, Alex Simpson)
 Logic, proof and types (David Aspinall)
 Concurrency and model-checking (Kousha Etessami, Paul Jackson)
 Logic and theory of concurrency (Julian Bradfield, Colin Stirling)
 Languages for programming and specification (Don Sannella)
 Programming for the Web (Phil Wadler)
 Mobility and Security (Don Sannella, David Aspinall, Ian Stark)
 Modelling and simulation (Jane Hillston)
 Algorithms and complexity (Mary Cryan, Leonid Libkin)
 Database theory and application (Peter Buneman, Wenfei Fan, Leonid Libkin)
 Software Engineering (Perdita Stevens, Stuart Anderson)

Key Research Highlights over last 5 years (these might include journal papers, awards, patents, spinout activity, etc. Please be selective, if necessary choose the top 10):

Wenfei Fan, Leonid Libkin, Peter Buneman:
 1. XPath Satisfiability in the Presence of DTDs

ACM Symposium on Principles of Database Systems (PODS), 2005 Michael Benedikt, Wenfei Fan, Floris Geerts

Invited for publication in JACM

2. Keys for XML

Computer Networks, Volume 39, Issue 5, August 2002, pp 473 - 487.

Peter Buneman, Susan Davidson, Wenfei Fan, Carmem Hara, WangChiew Tan.

The Best Paper of the Year Award for Computer Networks

3. On XML Integrity Constraints in the Presence of DTDs

Journal of the ACM (JACM), Volume 49 , Issue 3, pp 368 - 406, May 2002.

Wenfei Fan and Leonid Libkin

Development of a weakening of the notion of logical relations, called "pre-logical relations" (aka "lax logical relations") that has many of the features that make logical relations useful as a fundamental tool in the semantics of lambda calculus as well as further algebraic properties including composability. (Don Sannella)

Recipient of the first Roger Needham Award from the BCS for "PEPA and compositional approaches to performance modelling" in 2004. (Jane Hillston)

DEGAS project was selected as a "success story" of the IST programme in 2004. (Jane Hillston)

New work on PEPA showed how an emergent, population model could be derived as a continuous approximation of the detailed discrete model capturing the interactions of individuals. This has applications in the study of the scalability of large computer systems, epidemiology and systems biology.

Fulkerson Prize (with Sinclair and Vigoda) for "A polynomial-time approximation algorithm for the permanent of a matrix with nonnegative entries", J. ACM, Volume 51, Issue 4, 2004, Pages 671--697. (Mark Jerrum now at QMUL, but this work done at Edinburgh)

Graduate Student Research Training

See School of Informatics submission

Funding ('Current' Research Income, including sources):

Current research portfolio totals £7.7M

EPSRC: £6.5M

EU £1.1M

Other £0.1M

Key Collaborators: Academic and non academic, including overseas:

There are many collaborators. Some exemplars include:

David Harel (Israel), Klaus Keimel (Darmstadt), Martin Hyland (Cambridge) Furio Honsell (Udine), Paul Levy (Birmingham), Moshe Vardi (Rice), Masahito Hasegawa (RIMS, Kyoto), Dana Scott (CMU), Andrej Bauer (Ljubljana), Vincent Danos (Paris VII), Jiri Adamek (Braunschweig), Corrado Priami (Microsoft Research - University of Trento Centre for Computational and Systems Biology: Edinburgh/Trento Systems Biology), Jinpeng Huai (Vice-Principal, Beihang: Joint Edinburgh/Beihang interchange), Jean-Jacques Levy, Gerard Huet (INRIA), Tony Harmar, School of Biomedical Sciences, University of Edinburgh, Bob Mann, Astronomy, University of Edinburgh, Adriane Chapman, University of Michigan, Stijn Vansummeren, Hasselt University, Byron Choi, Technical University of Singapore, Ioannis Ioannides, University of Athens, Susan Davidson, University of Pennsylvania, Christoph Koch, Cornell, Martin Grohe, Humbolt, Sanjeev Khanna, University of Pennsylvania, Wang-Chiew Tan, University of California at Santa Cruz, Keishi Tajima, University of Kyoto, Cliff Jones (Newcastle), Leslie Goldberg (Liverpool), Martin Dyer (Leeds), Mark Jerrum (QMUL), Mihailis Yannakakis (Columbia), Andrzej Tarlecki (Warsaw), Michel Bidoit (ENS Cachan), Luke Ong (Oxford), Muffy Calder, Walter Kolch and Anna Dominiczak (Glasgow), Jeremy Bradley (Imperial College) Steve McLaughlin and Dave Laurenson, IDCOM, Bell Laboratories, Yahoo! Research, Google, Intel Research, University of British Columbia, University of Pennsylvania, Drexel University, University of Hassle National University of Singapore, The Chinese University of Hong Kong, Fudan University, Catholic Univ of Chile (M. Arenas), Univ of Chile (P. Barcelo), IBM Almaden (R. Fagin), U Calgary (D. Barbosa, soon to be joined by S. Kolahi), U Limburg, Belgium (F. Neven), INRIA, France (L. Segoufin) U Dortmund, Germany (T. Schwentick)

DATA SHEET:

Institution:	University of Edinburgh	Institute/ Group Name:		ICCS	
Main Contact:	Prof Johanna Moore	Institute/ Group Size			
Group webpage		Academic Researchers	70	Academic Staff	19
		PG Students	58		

Strategic Vision Statement (200 words max.):

The Institute for Communicating and Collaborative Systems (ICCS) is dedicated to the pursuit of basic and applied research in a wide range of areas of Cognitive Science, Artificial Intelligence, and Computer Science concerning dynamic aspects of cognition, including: wide-coverage parsing and statistical natural language processing, question answering, information extraction, statistical machine translation, computational syntax and semantics and their interaction in processing; human learning, human reasoning and psychologically realistic knowledge representation; the production and analysis of cooperative communication in a number of modalities including spoken and written text and dialogue, graphics and multimedia, and music.

Research Themes (provide a brief summary title for each theme and give the key lead contact(s)):

- Annotation and markup technology: Jean Carletta, Henry Thompson
- Biomedical natural language processing: Claire Grover, Ewan Klein, Bonnie Webber
- Computational psycholinguistics: Frank Keller, Jon Oberlander
- Computational semantics: Ewan Klein, Mirella Lapata, Alex Lascarides, Mark Steedman
- Dialogue Systems and Conversational agents: Oliver Lemon, Johanna Moore, Hiroshi Shimodara, Mark Steedman
- Discourse and dialogue: Jean Carletta, Alex Lascarides, Oliver Lemon, Colin Matheson, Johanna Moore, Bonnie Webber
- Technology enhanced learning: Johanna Moore, Helen Pain
- Human reasoning: Keith Stenning, Jon Oberlander
- Multimodal interaction: Jon Oberlander, Steve Renals, Hiroshi Shimodaira
- Natural language generation: Mirella Lapata, Johanna Moore, Jon Oberlander
- Natural language understanding, wide coverage parsing: Mark Steedman, Frank Keller, Miles Osborne
- Speech Recognition and Production: Steve Renals, Simon King
- Prosody and information structure: Rob Clark, Mark Steedman
- Question answering, Information extraction and Summarization: Claire Grover, Ewan Klein, Johanna Moore, Bonnie Webber
- Statistical machine translation: Philipp Koehn, Miles Osborne

Key Research Highlights over last 5 years (these might include journal papers, awards, patents, spinout activity, etc. Please be selective, if necessary choose the top 10):

In 2004, the Information Extraction group (in collaboration with partners in Stanford as part of the Edinburgh-Stanford Link) took part in 2 international competitions:

- BioCreAtIvE 1 (Critical Assessment of Information Extraction Systems in Biology) in 2004. The group achieved top scores in the Named Entity Recognition task.
- Bio-Entity Recognition task at Coling BioNLP. They achieved the second best score.

The IE group is in the process of demonstrating the commercial applicability of its text mining technology through a multi-million pound university/industry collaboration with the company Cogna funded by ITI Life Sciences, which will lead to a commercial application for curation of information from biomedical literature into database products.

In the 2006 TREC Question Answering track, the QA group achieved the top score in the "other" category, and their score for "factoid" questions was significantly above the mean. School of Informatics team led by Michael Kaiser (PhD student).

Bonnie Webber, Matthew Stone, Aravind Joshi, and Alistair Knott. Anaphora and Discourse Structure. Computational Linguistics, 29(4), 2003, pp. 545-587. This article introduces the theory that has led to the Penn Discourse TreeBank, the largest annotated discourse resource currently available. Release 1 of the Penn Discourse TreeBank (March 2006)

<http://www.seas.upenn.edu/~pdtb>

Frank Keller developed a method for using web counts in NLP research. This led to a best paper award (EMNLP 2002) and to two major journal papers (Computational Linguistics; ACM Transactions in Speech and Language Processing). The method is widely used and the papers are cited frequently (current citation count on Google Scholar: 111). [Joint work with Mirella Lapata.] This research was featured in the Economist in 2005 (both online and print editions):

http://www.economist.com/science/displayStory.cfm?story_id=3576374

Miles Osborne created the first application of gradient-based parameter estimation for Conditional Random Fields and showed how parameter estimation for CRFs can be made to scale with increasingly large training sets. Osborne has also produced the best parse selection performance for Head-driven Phrase Structure Grammar.

Miles Osborne and Philipp Koehn have created a Statistical Machine Translation group, which participated in the annual NIST machine translation competitions, beating Microsoft and a number of other companies and universities. The statistical machine translation system Moses, developed at the University of Edinburgh is in wide use.

Henry S. Thompson, was elected to the Technical Architecture Group of the World Wide Web Consortium for a 1-year term from February 2005, and re-elected for a further two years from February 2006. The TAG oversees and provides scientific guidance for all the work of the W3C. Dr. Thompson is the first academic to serve on the TAG, where he joins representatives- From IBM, Sun and Hewlett Packard among others.

In machine learning for dialogue strategies, Edinburgh's approach developed a strategy that outperforms all DARPA COMMUNICATOR hand-coded strategies (Henderson et al. IJCAI 2005); this result has been confirmed in evaluation with real users (Lemon et al. SLT 2006)

Graduate Student Research Training:

See School of Informatics submission

Funding ('Current' Research Income , including sources):

Total current research grant portfolio: £13.6M

Sources: EPSRC - £1.7M
EU - £5.1M
Other - £5.8M

Key Collaborators: Academic and non academic, including overseas:

- BBN: Ralph Weischedel
- Cambridge: Ann Copestake, Steve Young
- Carnegie Mellon University: Carolyn Rose
- ITC-irst: Marcello Federico, Cameron Shaw Fordyce
- MIT: Regina Barzilay, Michael Collins, Chao Wang and Wade Shen
- Systran: Jean Senellart
- MRC Human Genetics Unit: Wendy Bickmore, Duncan Davidson
- Rutgers University: Matthew Stone
- Stanford University: Dan Flickinger, Dan Jurafsky, Chris Manning, Clifford Nass, Stanley Peters, Byron Reeves, Barbara Tversky, Annie Zaenen
- University of Pennsylvania: Aravind Joshi
- University of Pittsburgh: Diane Litman
- University of the Saarlandes/DFKI: Tilman Becker, Matthew Crocker, Anette Frank , Manfred Pinkal, Andreas Eisele, Hans Uskoreit
- USC/ISI: Kevin Knight, Daniel Marcu, David Chiang
- University of Texas at Austin: Nicholas Asher, Jason Baldrige
- Amazon Research UK
- AT&T: Pino di Fabbrizio, Mazin Gilbert
- Google: Franz Och, Thorsten Brants
- Cogna
- Memex
- Graham Technologies:

DATA SHEET:

Institution:	University of Edinburgh	Institute/ Group Name:	Institute for Adaptive and Neural Computation (ANC)		
Main Contact:	Prof C K I Williams	Institute/ Group Size	70.35		
Group webpage	anc.ed.ac.uk	Academic Researchers	9	Academic Staff	8.35
		PG Students	53		

Strategic Vision Statement (200 words max.):

The Institute studies adaptive processes in both artificial and biological systems. It encourages interdisciplinary and collaborative work involving the traditional disciplines of neuroscience, cognitive science, computer science, computational science, mathematics and statistics.

Many of the information-processing tasks under study draw on a common set of principles and mathematical techniques for their solution. Combined study of the adaptive nature of artificial and biological systems facilitates the many benefits accruing from treating essentially the same problem from different perspectives.

One major theme is the study of artificial learning systems. This includes theoretical foundations (e.g. statistical theory, information theory), the development of new models and algorithms, and applications.

A second major theme is the analysis and modelling of brain processes at all levels of organization with a particular focus on theoretical developments which span levels. Within this theme, research areas are broadly defined as the study of the neural foundations of perception, cognition and action and their underlying developmental processes.

We also construct and study computational tools and methods that support this research - for example in the analysis of brain data, simulation of networks, and parallel data mining.

Research Themes (provide a brief summary title for each theme and give the key lead contact(s)):

The main areas of work are machine learning, bioinformatics and neuroinformatics. However, note that the bioinformatics research is described under the Edinburgh Centre for Bioinformatics return.

Machine Learning: This group focuses on machine learning problems, including theoretical foundations (e.g. statistical theory, information theory), the development of new models and algorithms, and applications. There is a significant emphasis on problems in image modelling/interpretation and stochastic processes, as well as an interest in manifold learning, Gaussian processes, clustering methods and signal analysis. Much of the group's work is applied to problems of scientific inference, including research in areas of astronomy, remote sensing, meteorology, medical imaging, medical signal processing, compiler optimization, neuroinformatics and bioinformatics. For further details please see www.anc.ed.ac.uk/machine-learning.

Lead Contact: Prof Chris Williams

Neuroinformatics: in this newly-emerging research area, scientists from the mathematical/physical/computer sciences come together with neuroscientists to develop and apply new methods for understanding the development and functioning of the brain. Neuroinformatics has three main areas: computational modelling of the brain, development and use of neural databases, and the development and application of simulation and analytical tools. Edinburgh has a strong tradition in neuroinformatics, particularly in the area of computational modelling. ANC staff develop and apply models to many different levels of the nervous system; these include models of synaptic plasticity, the functioning of the basal ganglia – which are changing the ways in which we understand and treat motor disorders – the development of nerve connections, computational models of primate vision and visual development, and models of specific cognitive functions. ANC is host to the Neuroinformatics Doctoral Training Centre (www.anc.ed.ac.uk/neuroinformatics), and ANC staff direct the UK Network in Neuroinformatics (www.neuroinformatics.org.uk). ANC staff develop simulation tools based on the neural simulators GENESIS and NEURON, and ANC hosts the annual summer school on neuroinformatics simulation tools.

Lead Contact: Prof David Willshaw.

Key Research Highlights over last 5 years (these might include journal papers, awards, patents, spinout activity, etc. Please be selective, if necessary choose the top 10):

Neuroinformatics

* ANC is the focus for neuroinformatics and computational neuroscience research in the UK, hosting the EPSRC/MRC funded Doctoral Training Centre in Neuroinformatics (first intake 2002).

* Prof Willshaw is a pioneer of computational neuroscience. He is renowned for his work on the theory of associative memory and for his novel predictive models for the development of nerve connections. His recent analysis of new experimental work on the effects of genetic manipulations of the brain's wiring diagram (Willshaw, *Development* 133, 2705-2717, 2006) has proposed a solution for one classic problem in neurobiology: that ordered maps of connections in the brain are formed as a result of molecular guidance cues, rather than electrical signalling as hitherto thought.

* A second strand of Willshaw's work is in the development of models of basal ganglia function; in particular, models of the subthalamic nucleus, a part of the basal ganglia targeted in the treatment of Parkinsonism by Deep Brain Stimulation (Gillies & Willshaw, *J Neurophysiol*, in press).

* Dr van Rossum works at the interface of computer science and neuroscience to work out the computational principles of the nervous system. His research focus includes visual processing (Clark & van Rossum, *N. Comp.* 18, 26-44, 2006) and signal propagation in neuronal structures (van Rossum et al, *J. Neurosci.* 22, 1956-1966, 2002). His seminal work on spike timing dependent plasticity has received over 80 citations.

* Dr Bednar works on biologically realistic computational modelling of the human visual system. He co-authored (with R Miikkulainen, Y Choe, and J Sirosh) the book *Computational Maps in the Visual Cortex* (Springer, 2005), the first book to appear on computational modelling of the visual cortex at the map level. Dr Bednar is also lead author of the related Topographica cortical simulator (see topographica.org).

* Dr Shillcock works on psycholinguistics, connectionist cognitive modelling, and computational psycholinguistics. A highlight of his recent work is a new connectionist model of reading, involving both single words and text, based on the observation that the human fovea is precisely, vertically split and projects initially to the contralateral hemispheres of the brain. This has implications for normal and impaired reading. Monaghan and Shillcock, *Psychological Review*, 111(2), 283-308.

Machine Learning

* Prof Williams is a world leading researcher in probabilistic machine learning, and pioneered Gaussian process (GP) prediction in machine learning. He co-authored (with Carl Rasmussen) the book *Gaussian Processes for Machine Learning* (MIT Press, 2006) which provides a long-needed systematic and unified treatment of theoretical and practical aspects of this field.

* Prof Bishop is a world leading researcher in machine learning. His recent book *Pattern Recognition and Machine Learning* (Springer, 2006) is targeted to become widely adopted as the leading text in the machine learning field. The book sets out a modern approach to machine learning based on probabilistic graphical models and Bayesian inference. The book's predecessor (*Neural Networks for Pattern Recognition*, OUP, 1995) has sold 25,000 copies.

* Dr Storkey works in probabilistic machine learning and image understanding. His work on cleaning sky-survey databases of spurious objects using machine learning techniques has been fielded in the SuperCosmos sky-survey database. This work was done in collaboration with astronomer colleagues. Storkey, Hambly, Williams, Mann; *Mon. Not. Roy. Astron. Soc.*, 347 36-51, 2004.

Graduate Student Research Training (Please provide brief details of type of training provided, including current numbers of students as well as the typical number of advanced degrees (MPhil & DPhil) awarded annually):

See School of Informatics submission

Funding ('Current' Research Income, including sources):

MRC	£1,380K
EPSRC	£325K
EC	£131K
Royal Society of Edinburgh	£125K
Microsoft	£56.5K
HFSP	£45.9K
Scottish Enterprise	£10.5K

Total: £2M

Key Collaborators: Academic and non academic, including overseas:

Institutional

The 4 Bernstein Centres in Computational Neuroscience (Germany)

RIKEN Brain Science Institute, Tokyo

EU PASCAL Network of Excellence in Machine Learning

Leading the EPSRC/MRC/BBSRC funded UK Neuroinformatics Network in Neuroinformatics (established 2005). The Network is linked closely to the International Neuroinformatics Coordinating Facility, an international organisation recently set up through the OECD and dedicated to coordinating the development of neuroinformatics worldwide.

Individual

Prof Y Choe (Computer Science, Texas A&M University, USA)

Prof M Denham (Neuroscience, Plymouth)

Dr D Donaldson (Psychology, Stirling)

Dr S Eglén (Applied Mathematics and Theoretical Physics, Cambridge)

Dr Bruce Graham (Computer Science, Stirling)

Prof G Hinton (Computer Science, Toronto, Canada)

Dr B Horwitz (National Institutes of Health, USA)

Dr P Monaghan (Psychology, York)

Prof R Miikkulainen (Computer Sciences, U of Texas at Austin, USA)

Prof R Morris (Neuroscience, Edinburgh)

Dr M Oram (Psychology, St. Andrews)

Dr C Rasmussen (Max Planck Inst for Biological Cybernetics, Tuebingen, Germany)

Prof R Ribchester (Neuroscience, Edinburgh)

Prof I Thompson (Halliburton Chair of Physiology, KCL)

Prof A Zisserman (Engineering Science, Oxford)

DATA SHEET:

Institution:	University of Edinburgh	Institute/ Group Name:	Centre for Speech Technology Research (CSTR)		
Main Contact:	Prof Steve Renals	Institute/ Group Size	33 + 2 admin		
Group webpage http://www.cstr.ed.ac.uk		Academic Researchers	13	Academic Staff	4
		PG Students	16		

Strategic Vision Statement (200 words max.):

CSTR is a research centre linking Informatics and Linguistics. The motivation that underlies our research is to answer the question: How can machines make sense of human communication? Our approach is interdisciplinary, starting from the signal, and focusing on speech communication. Main areas of interest include speech recognition, speech synthesis and multimodal interaction.

The interdisciplinarity of CSTR is reflected in its location, institutional position, graduate teaching and research outlook. Our research is characterised by the use of approaches from machine learning and signal processing, that are well-informed by recent findings in speech science. Examples of this interdisciplinary approach include the use of articulatory constraints in speech recognition and synthesis and the development of perceptual evaluation methodologies.

Our current research goals include rapid adaptation of speech recognition and synthesis to new domains, unified modelling for speech recognition and synthesis, multilingual systems (using language independent/adaptive approaches), and communication scene analysis: modelling multimodal communication between multiple people.

Research Themes (provide a brief summary title for each theme and give the key lead contact(s)):

Speech Recognition (Prof S Renals, Dr S King, Dr H Shimodaira): Our research in speech recognition falls in four main areas.

1. Development of systems for the recognition of large vocabulary tasks, in particular multiparty conversations, with an emphasis on microphone array-based approaches.
2. Development of novel acoustic models based on streamed and factorised approaches (dynamic Bayesian networks), models utilizing articulatory constraints, trajectory models of speech, and models using discriminative features.
3. Development of novel language models using streamed and factorised approaches, and hierarchical Bayesian models.
4. Rapid adaptation to new domains (eg dialogue systems, systems for elderly users, language-independent models).

Speech Synthesis (Dr R Clark, Dr S King): Much of our work in speech synthesis is based around the widely-used open source Festival system, developed at CSTR:

1. Further development of unit selection speech synthesis, including the prediction and realisation of expressive prosody
2. Incorporation of articulatory constraints in speech synthesis
3. Trajectory models for speech synthesis and the development of unified approaches to synthesis and recognition
4. Speech synthesis in the context of cognitive and/or auditory ageing

Multimodal Interaction (Prof S Renals, Dr H Shimodaira): Our work in multimodal interaction covers two main areas:

1. Communication scene analysis: understanding and interpreting human-human communication across multiple modalities, including segmentation, structuring and summarization of meetings
2. Human-computer dialogue using reinforcement learning, and through the development of multimodal conversational agents.

Key Research Highlights over last 5 years (these might include journal papers, awards, patents, spinout activity, etc. Please be selective, if necessary choose the top 10):

1. Festival: open source unit selection speech synthesis engine, in wide use (50,000 downloads); performed well in most recent evaluations of speech synthesis (Blizzard).
2. AMI: multimodal meetings corpus (Creative Commons licence) and evaluation protocols for multiparty interactions. Largest, best-annotated, corpus of its kind, with the development of automatic annotation approaches, in many cases defining the state of the art (eg summarization and dialogue act segmentation)
3. One of two best-performing systems in 2005 and 2006 NIST meeting speech recognition evaluations
4. Spinout of Cereproc (speech synthesis)
5. Coordinator of 2 EU Integrated Projects (AMI and AMIDA) and 1 Marie Curie Project (EdSST)

Graduate Student Research Training (Please provide brief details of type of training provided, including current numbers of students as well as the typical number of advanced degrees (MPhil & DPhil) awarded annually):

See School of Informatics submission

Funding ('Current' Research Income , including sources):

EPSRC: £1.95M
Scottish Enterprise: £574K
Scottish Funding Council SRDG: £230K
EU IST Programme Integrated Projects: £3.1M

Total: £5.85

Key Collaborators: Academic and non academic, including overseas:

IDIAP Research Institute, Martigny, Switzerland (Prof H Bourlard, Prof H Hermansky)
International Computer Science Institute, Berkeley CA, USA (Prof N Morgan)
Stanford University (Prof D Jurafsky)
University of Sheffield (Dr T Hain, Prof P Green, Prof S Whittaker, Prof M Cooke)
Queen Margaret University College, Edinburgh (Prof W Hardcastle, Dr J Scobbie)
Nagoya Institute of Technology (Prof K Tokuda)
Visual Nexus Ltd, Guildford, UK (Mr S Davies)
Cereproc Ltd, Edinburgh (Dr M Aylett)
University of Glasgow (Prof S Brewster, Dr R Murray-Smith)
TNO, Netherlands (Dr W Kraaij, Dr W Post)
Technical University of Brno, Czech Republic (Dr L Burget, Dr J Cernocky)
Carnegie Mellon University (Prof A Black)
IIT Guwahati, India (Prof S Prasanna)
CSIRO eHealth Institute, Australia (Dr I McCowan)

DATA SHEET:

Institution:	University of Edinburgh	Institute/ Group Name:	Institute of Perception, Action & Behaviour (IPAB)		
Main Contact:	Dr. Sethu Vijayakumar	Institute/ Group Size			
Group webpage: http://www.ipab.informatics.ed.ac.uk/		Academic Researchers	4	Academic Staff	6
		PG Students	29		

Strategic Vision Statement (200 words max.):

One of the central issues of 21st Century Informatics will be how to link, in theory and in practice, computational perception, representation, transformation and generation processes to external worlds. The external world may be the "real" world or another computational environment that has its own character. Examples of where this issue arises include bio-mimetic robotics, computer-based visual perception, dynamic control of the interaction of robotic systems with their environment or each other, computer-based generation of external phenomena, such as images, music or actions, and agent-based interaction with other agents or humans, as in computer games. At IPAB, we study a variety of such problem through formal modelling and embodied implementations. We use methods such as Bayesian inference, hidden Markov models and statistical learning to model and investigate a broad variety of topics from insect sensing and behaviour to motor control in robotic and biological systems. One of the key future themes of the institute is 'Learning based vision and robotics' with an emphasis on scalability and dynamic interactions – a topic that is central to the success of truly autonomous systems of tomorrow. We will continue our strong ties with the industry in the field of robotics, computer vision and machine perception such that theoretical and empirical advances made in these fields at our institute can be effectively applied to tackle real world problems.

Research Themes (provide a brief summary title for each theme and give the key lead contact(s)):

Machine Learning and Sensorimotor Control: Dr. Sethu Vijayakumar

- machine learning algorithms for high dimensional sensorimotor systems
- humanoid and anthropomorphic robot control (including sensing, planning)

Biorobotics: Dr. Barbara Webb

- understanding insect sensorimotor systems
- building robot models that mimic and exploit insights from biology

Mobile Robotics and Reinforcement Learning: Dr. Gillian Hayes

- reinforcement learning theory and scalability
- mobile robot navigation and sensing

Computer Vision: Prof. Robert Fisher

- 3D imaging
- video-based behaviour understanding

Graphics, Animation and Biophysical Modelling: Dr. Taku Komura, Dr.

Eric McKenzie

- Analysis of human motions using a musculoskeletal model
- Simulating interactions of multiple avatars
- Visualization and capturing domain knowledge

Key Research Highlights over last 5 years (these might include journal papers, awards, patents, spinout activity, etc. Please be selective, if necessary choose the top 10):

- Invited article for Nature: "Robots in invertebrate neuroscience" (Barbara Webb) vol. 417,359-363, 2002
- Spinout: Dimensional Imaging (formerly Virtual Clones), Edinburgh Robotics
- Led CAVIAR EC project - main lasting contribution is ground truth annotated datasets 12+K accesses since March 2005. (Prof. Fisher)
- COnline: research resource 590+K accesses since Nov 1999. (Prof. Fisher)
- Dictionary of Computer Vision and Image Processing, R. B. Fisher, K. Dawson-Howe, A. W. Fitzgibbon, C. Robertson, E. Trucco John Wiley and Sons, 2005 (well selling -- 2nd printing)
- Hosted 2006 British Machine Vision Conference (largest ever - 200+ delegates)
- Collaborative industrial ties with leading industrial partners such as HONDA Research, SONY-Japan, Microsoft-Cambridge, Dimensional Imaging

Graduate Student Research Training (Please provide brief details of type of training provided, including current numbers of students as well as the typical number of advanced degrees (MPhil & DPhil) awarded annually):

See School of Informatics submission

Funding ('Current' Research Income, including sources):

EPSRC: £800K

EU: £5.03M

Total: £5.8M

Key Collaborators: Academic and non academic, including overseas:

- Stefan Schaal: Computer Science & Neuroscience, University of Southern California
- Mitsuo Kawato: Computational Neuroscience, Advanced Telecommunications Research (ATR) Intl., Kyoto, Japan
- Dr. Christian Goerick: Humanoid Department, HONDA Research Institute, Germany
- Shun-ichi Amari: Director, RIKEN Brain Science Institute, Tokyo, Japan
- Prof. Andrew Blake, Microsoft Research Ltd., Cambridge, UK

- Berthold Hedwig: Dept. of Zoology, University of Cambridge
- Alister Hamilton and Rebecca Cheung: UoE Electrical and Electronics
- Paolo Arena, DIEES, University of Catania
- Akinori Nagano: University of Aberdeen, UK
- Howard Leung: City University of Hong Kong
- Shigeo Morishima: Waseda University, Japan
- Ryutaro Himeno: Riken, Japan
- Yoshihisa Shinagawa : UIUC, USA
- Franck Multon: IRISA, France
- Rynson Lau : Durham, UK
- Dimensional Imaging (Formely Virtual Clones)
- Toby Bailey: UoE Mathematics (Geometry)
- Jonathan Rees: UoE Dermatology (Skin Cancer)

DATA SHEET:

Institution:	University of Edinburgh, Sol	Institute/ Group Name:		Prospekt Program	
Main Contact:	Colin Adams	Institute/ Group Size		5	
Group webpage www.inf.ed.ac.uk/admin/committees/prospekt/		Academic Researchers	N/A	Academic Staff	N/A
		PG Students			

Strategic Vision Statement (200 words max.):

Prospekt aims to develop a high quality practice of executing commercialisation activity associated with the academic research coming from the School of Informatics and its associated programs. This commercialisation will take the form of

- o Generating start-up companies
- o Licensing of IP generated by research
- o Commercial research projects carried out in association with Industry

The project will also work on developing a more entrepreneurial culture within the School and its students. This will be implemented via a series of postgraduate courses in Entrepreneurship and a program of placing research students with appropriate industrial partners

Project will also look at improving the outreach activities of the School in developing links with local and worldwide industry, the School's Alumnus network and the general public to improve relations and understanding of the Schools activities. This will take the form of developing an outreach web presence for non academics, developing the use of the IN-Space facility at the new Informatics Forum for better understanding of Science and developing a series of events to improve interaction with potential industrial partners.

Key Commercialisation Highlights over last 5 years (these might include journal papers, awards, patents, spinout activity, etc. Please be selective, if necessary choose the top 10):

Commercialisation activity over the last 5 years includes:

Technology Disclosures: 75
 Patents filed: 8
 Commercial Licenses: 14
 Spin out companies: 6
 Start up companies: 14

In addition there are many thousands of downloads of open source software packages/systems.

Graduate Student Research Training (Please provide brief details of type of training provided, including current numbers of students as well as the typical number of advanced degrees (MPhil & DPhil) awarded annually):

Entrepreneurship Courses offered as part of MSc program, typically 45 students per year taking course for credit, a number of other PhD students monitor course.

Funding ('Current' Research Income , including sources):

Funding From SEEL £4.9M awarded over 5 years matched to £3.24M from University of Edinburgh

Key Collaborators: Academic and non academic, including overseas:

A number of MoUs have been signed with major research collaborators(eg with Moscow State University, Riken Institute in Japan etc) and dozens of interactions with commercial organisations ranging from formal research collaborations (eg with IBM, Sun Microsystems, Microsoft, Cognia etc) to participation in networking, Masterclasses for local start ups and industry events.

DATA SHEET:

Institution:	The School of Informatics	Institute/ Group Name: Edinburgh Centre for Bioinformatics		
Main Contact:	Prof. Igor Goryanin	Institute/ Group Size		
Group webpage www.bioinformatics.ed.ac.uk		Academic Researchers	70	Academic Staff
				30

Strategic Vision Statement (200 words max.):

The Edinburgh Centre for Bioinformatics is a collaboration between life scientists, computer scientists and other physical scientists to stimulate and support collaborative interdisciplinary research in bioinformatics.

In Edinburgh we have one of the largest and best groups of researchers with interests in bioinformatics in the UK. The network and collaborations underpinning the Edinburgh Centre for Bioinformatics draw on several highly-rated academic Schools within the University of Edinburgh, on other Universities and on world-leading biological and biomedical Research Institutes in and around the City. Within the University of Edinburgh, bioinformatics research mainly involves the College of Science & Engineering (the School of Biological Sciences and the School of Informatics) and the College of Medicine and Veterinary Medicine.

The mission of Edinburgh Centre for Bioinformatics is to:

- Provide support for new ground level initiatives in the Edinburgh in Bioinformatics and Systems Biology fields.
- Integrate teaching related activities across the University of Edinburgh groups.
- Act as a focal point for Bioinformatics and Systems Biology in the local area.
- Collaborate with the Bioinformatics institutes in Glasgow and Dundee to promote Bioinformatics and System Biology activities in the Scotland.
- Identify and lead several high profile research programmes.

Research Themes (provide a brief summary title for each theme and give the key lead contact(s)):**Overview**

We have strong research themes in systems biology, neuroinformatics; machine learning analysis and database solutions for protein and gene expression data (both microarray and in situ datasets); biological ontologies, knowledge management and text mining; evolutionary and population genetics in plants and animals, and in human molecular diseases. These span many academic departments at Edinburgh and links and summaries are available on-line at <http://www.bioinformatic.ed.ac.uk/>

Selected examples:

Computational Systems Biology, Professors Igor Goryanin and Andrew Millar

Modelling is central to systems biology, taking existing knowledge, often in the form of large datasets, and through static and kinetic models, using it to generate new knowledge. The unique feature of CSBE is that we place this process itself at the centre of our scientific endeavour. Modelling will be supported by the Systems Biology Software Infrastructure, a new integrated platform, facilitating the modelling process from databases to knowledge discovery. This will encompass model construction by a variety of means including graphical notation and network inference, as well as a suite of tools for model analysis including both static and kinetic analyses. Its development will be informed by biological projects, initially in three areas: RNA metabolism in yeast, interferon signalling in macrophages and the circadian clock in Arabidopsis. On the experimental side the Kinetic Parameter Facility will provide essential data to parameterise kinetic models.

Neuronal Systems Biology, J Douglas Armstrong

Models of the post-synaptic proteome and the structure/functional relationships in the complex. Analysis of information flow through the molecular complex and modeling gene/protein disruptions. The development of laboratory software to support large scale integrative neuroscience (information management and analysis, computer vision and tracking)

Key Research Highlights over last 5 years (these might include journal papers, awards, patents, spinout activity, etc. Please be selective, if necessary choose the top 10):

Selected recent papers:

Armstrong JD, Pocklington AJ, Cumiskey MA, Grant SGN. (2006) Reconstructing protein complexes: from proteomics to systems biology. *Proteomics* 6, 4724 - 4731.

Pocklington AJ, Cumiskey M, Armstrong JD, Grant SGN (2006) The proteomes of neurotransmitter receptor complexes form modular networks with distributed functionality underlying plasticity and behaviour. *Molecular Systems Biology*, 2, msb4100041-E1-E14.

Locke J.C.W., Southern M.M., Kozma-Bognar L., Hibberd V., Brown P.E., Turner M.S., Millar A.J. (2005) Extension of a genetic network model by iterative experimentation and mathematical analysis. *Molecular Systems Biology*, doi: 10.1038/msb4100018.

Grimes GR, Wen TQ, Mewissen M, Baxter RM, Moodie S, Beattie JS, Ghazal P.

PDQ Wizard: automated prioritisation and characterisation of gene and protein lists using biomedical literature. *Bioinformatics*. 2006 Jun 29

Metelkin, E, Goryanin, I, Demin, O.(2006) Mathematical Modeling of

Mitochondrial Adenine Nucleotide Translocase, Biophysical Journal, 15; 90 (2): 423-32

Moehren G, Markevich N, Demin O, Kiyatkin A, Goryanin I, Hoek JB, Kholodenko BN. (2002) Temperature dependence of the epidermal growth factor receptor signaling network can be accounted for by a kinetic model. Biochemistry, 8; 41 (1) : 306 – 320.

Sorokin A., Paliy K., Selkov A., Demin O., Dronov S., Ghazal P. and Goryanin I. (2006) The Pathway editor: A tool for managing complex biological networks, IBM Journal research & Development. 6 :561 - 575

Goryanin I (2006) Cellular Modelling of Biochemical Processes in Microorganisms” In “Microbial Proteomics: Functional Biology of Whole Organism” Editors Ian Humphrey-Smith and Michael Hecker, John Wiley & Sons, 2006

Wilson WH, Schroeder DC, Allen MJ, Holden MT, Parkhill J, Barrell BG, Churcher C, Hamlin N, Mungall K, Norbertczak H, Quail MA, Price C, Rabbinowitsch E, Walker D, Craigon M, Roy D, Ghazal P. Complete genome sequence and lytic phase transcription profile of a Coccolithovirus. Science. 2005 Aug 12;309(5737):1090-2.

Graduate Student Research Training (Please provide brief details of type of training provided, including current numbers of students as well as the typical number of advanced degrees (MPhil & DPhil) awarded annually):

See ICT return by School of Informatics Graduate School

Funding ('Current' Research Income , including sources):

The bioinformatics research groups across Edinburgh are currently supported by research grant funding totally around £61M. These funds are from a variety of public, charitable and commercial sources and are broken down roughly as follows (£M):

EPSRC	MRC	BBSRC	Wellcome Trust	EU	Industry	other
7.77	4.42	12.16	15.21	5.47	2.64	13.45

Key Collaborators: Academic and non academic, including overseas:

Collaborators with ECB academic staff include:

- Wellcome Trust Sanger Institute
- Universities of Glasgow, Dundee, Herriot Watt, Manchester, Cambridge
- Roslin
- BIOSS

- Systems Biology (Kitano), Riken, Moscow State University,
- University of Barcelona,
- GSK
- Rice University, USA
- UMASS Medical School, USA
- Systems Biology Institute, Japan
- Sony, Japan
- RIKEN Genomic Sciences Centre, Japan
- Free University in Amsterdam, Holland ,
- European Bioinformatics Institute
- RTK Consortium

DATA SHEET:

Institution:	The University of Edinburgh	Institute/ Group Name:	EPCC		
Main Contact:	Prof. A S Trew	Institute/ Group Size	73		
Group webpage http://www.epcc.ed.ac.uk/		Academic Researchers	50	Academic Staff	1
		PG Students	29		

Strategic Vision Statement (200 words max.):

EPCC was established in 1990 as the focus for the University of Edinburgh's work in high performance computing (HPC) and its application to computational challenges in a wide variety of disciplines.

The Centre's mission is to accelerate the effective exploitation of HPC and novel computing throughout academia, industry and commerce. It houses an exceptional range of computers, with over 70 full-time staff committed to the solution of real-world problems. Our goal is to enable the University to become the European leader in computational science (spanning both HPC and Grid).

Achieving that goal requires that we combine activities across different research and development areas and link academia to industry. Specifically, we have identified six areas to be developed individually, but linked in such a way that they provide cross support. These areas are: HPC research and development (inc software engineering); HPC facilities and skills; Grid expertise; PG Training, Technology Transfer; European Leadership (best practice, co-ordination and roadmapping). Through the skills of EPCC, the National e-Science Centre (NeSC), the Digital Curation Centre, Informatics and key applications Institutes we are well-positioned to achieve that goal.

Note: the computational science aspects of EPCC's work were reported to the EPSRC's "International Review of Research using HPC in the UK" in 2005. In the following, therefore, we restrict ourselves to work not reviewed there.

Research Themes (provide a brief summary title for each theme and give the key lead contact(s)):

- HPC Performance Optimisation (Dr Stephen Booth)
- HPC Benchmarking (Dr Lorna Smith)
- Grid Computing (Dr Mark Parsons)
- Distributed Data Access and Integration (Mr Neil Chue Hong)
- Java for High Performance Computing (Dr Mark Bull)
- Parallel Computing (Dr Alan Simpson)
- High-Performance Reconfigurable Computing using FPGAs (Dr Rob Baxter)

Key Research Highlights over last 5 years (these might include journal papers, awards, patents, spinout activity, etc. Please be selective, if necessary choose the top 10):

- M Plummer, J Hein, M F Guest, K Mellow, I J Bush, K Refson, G J Pringle, L Smith and A Trew, "Tera-scale materials modelling on high performance system HPCx", feature article, accepted for publication in the Guest Editor Issue on High Performance Computing, J. Mat. Chem, 2006.
- Mario Antonioletti, Malcolm Atkinson, Rob Baxter, Andrew Borley, Neil P. Chue Hong, Brian Collins, Neil Hardman, Alastair C. Hume, Alan Knox, Mike Jackson, Amy Krause, Simon Laws, James Magowan, Norman W. Paton, Dave Pearson, Tom Sugden, Paul Watson, Martin Westhead, The design and implementation of Grid database services in OGSA-DAI, Concurrency and Computation: Practice and Experience Volume 17, Issue 2-4 , Pages 357 - 376, Feb 2005.
- Hein, J., Reid, F., Smith, L., Bush, I., Guest, M. & Sherwood, P. 2005. On the performance of molecular dynamics applications on current high-end systems. Phil. Trans. R. Soc. A 363, 1987-1998 (doi:10.1098/rsta.2005.1624).
- J. Perry, L. Smith, A. N. Jackson, R. D. Kenway, B. Joo, C. M. Maynard, A. Trew, D. Byrne, G. Beckett, C. T. H. Davies, S. Downing, A. C. Irving, C. McNeile, Z. Sroczynski, C. R. Allton, W. Armour, J. M. Flynn, "QCDgrid: A Grid Resource for Quantum Chromodynamics", Journal of Grid Computing, Volume 3, page 113, 2005.
- J. M. Bull, L. A. Smith, C. Ball, L. Pottage and R. Freeman, *Benchmarking Java against C and Fortran for Scientific Applications*, Concurrency and Computation: Practice and Experience, Volume 15, Issue 3-5, pp17-430, 2003.
- A. C. Carter, A. J. Bray, and M. A. Moore, *Aspect-Ratio Scaling and the Stiffness Exponent θ for Ising Spin Glasses*, Phys. Rev. Lett. 88, (2002) p077201.
- UKQCD Collaboration (C.R. Allton et al. (19)), *Effects Of Nonperturbatively Improved Dynamical Fermions In Qcd At Fixed Lattice Spacing*, Phys.Rev.D65:054502, 2002.
- M.G. Beckett, J.A. Mackenzie, A. Ramage, and D.M. Sloan, *Computational solution of two-dimensional unsteady PDEs using moving mesh methods*, Journal of Computational Physics, Vol. 182, pp. 478-495, 2002.
- K. Stratford and K. Haines, *Modelling changes in the Mediterranean thermohaline circulation 1987-1995*, Journal of Marine Systems, 33-34, 51 (2002).
- K. Stratford and K. Haines, *Modelling nutrient cycling in the eastern Mediterranean transient event 1987-1995 and beyond*, Geophysical Research Letters, 29(3), 10.1029/2001GL013559, (2002)

Graduate Student Research Training (Please provide brief details of type of training provided, including current numbers of students as well as the typical number of advanced degrees (MPhil & DPhil) awarded annually):

EPCC offer a one-year Masters course in HPC. This includes both a taught component, consisting of a series of intensive modules, and a dissertation, based on a practical research project. The MSc in HPC appeals to students who have a keen interest in programming and would like to learn about HPC and parallel computing. We attract students who hold degrees in the physical sciences, engineering, computer science or mathematics, or who have equivalent work experience. 27 full and part-time students are enrolled for the academic year 2006-2007.

Additionally, EPCC currently hosts 2 PhD students in topics related to high performance computing and grid computing. Additionally, EPCC staff supervise PhD students registered with other university departments.

We are one of the UK's two High-End Computing Training Centres, providing HPC training to UK's PhD students in the physical sciences. In general, EPCC is a major provider of training in High Performance Computing (HPC) in Europe, offering a range of well-established courses for users of HPC throughout the UK and Europe.

Funding ('Current' Research Income, including sources):

EPSRC: £1.8M
EU: £7.4M
Industry: £2.5M
Other: £2.2M

HPCx Research Contract (EPSRC): £54.6M

Key Collaborators: Academic and non academic, including overseas:

The Globus Alliance; EPCC is a member of the Alliance.
The FPGA High Performance Computing Alliance; EPCC is a founding member.
IBM
British Telecom
Fujitsu
LogicaCMG
Atos Origin
Consorzio Interuniversitario del Nord est Italiano Per il Calcolo Automatico (CINECA)
Barcelona Supercomputing Center
Stichting Academisch Rekencentrum Amsterdam (SARA)
Institut du Développement et des Ressources en Informatique (IDRIS)
Conseil Européen pour la Recherche Nucléaire (CERN)
Forschungszentrum Jülich

DATA SHEET:

Institution:	University of Edinburgh	Institute/ Group Name:	Edinburgh e-Science		
Main Contact:	Malcolm Atkinson	Institute/ Group Size	40		
Group webpage www.nesc.ac.uk		Academic Researchers	4	Academic Staff	2
		PG Students	3		

Strategic Vision Statement (200 words max.):

In the five years since its inception, the e-Science Institute (eSI) has stimulated and organised meetings for the UK's e-Science community and of hosting visitors who interact with that community. The initial programme was shaped to build the UK's e-Science community across all disciplines, to help it develop an understanding of the challenges and available solutions, and to develop skills.

Now the main thrust is changing to focus on longer-term and research centred topics. This is achieved by running themes that develop a topic over a period of six months to a year, through a series of workshops and meetings at eSI and elsewhere. The choice of themes and theme leaders is competitive, and will be recommended to the Director by the Science Advisory Board. We are already running two themes under this regime and have two more in the pipeline.

We will continue to run the e-Science Institute, developing as a centre stimulating international research in e-Science. We will develop advanced techniques for exploiting research data in inter-disciplinary projects. We will continue to lead e-Science and Grid training and education activities in Europe and the UK

Research Themes (provide a brief summary title for each theme and give the key lead contact(s)):

E-science data management in multidisciplinary applications. Contact: Malcolm Atkinson.

Key Research Highlights over last 5 years (these might include journal papers, awards, patents, spinout activity, etc. Please be selective, if necessary choose the top 10):

- OGSA-DAI project delivering a platform for research to 1500 organisations
- International data services standards – WS-DAI and the OGSA Data Services Architecture
- AstroGrid – contributing to a functioning Grid for the International

Virtual Observatory

- GridPP – contributing to a functioning Grid for the Large Hadron Collider
- Developing a Grid architecture for the Mouse Atlas and related work studying gene expression in mice and humans.

Graduate Student Research Training (Please provide brief details of type of training provided, including current numbers of students as well as the typical number of advanced degrees (MPhil & DPhil) awarded annually):

Annual International Summer School on Grid Computing: 60 students/year
E-Science M.Sc.: 8 students/year

Funding ('Current' Research Income , including sources):

£9,664,405 total value of current awards held in the institute, from EPSRC, PPARC, EU, JISC, MRC, DTI and Industry. Of this, £7,594,345 funds institute staff; the remainder funds staff elsewhere. Conversely, some staff are funded by grants held in other institutes from EPSRC, SFC, DTI, BBSRC and others.

Key Collaborators: Academic and non academic, including overseas:

- Universities of Glasgow, Manchester, Southampton, Newcastle, UCL, Oxford, CCLRC
- MRC Human Genetics Unit, EBI, Roslin Institute, Buildings Research Establishment,
- Argonne National Lab, ISI, SDSC, UCSD, The Globus Alliance,
- CERN, KTH(Stockholm), KMZ(Karlsruhe), Catania, Naples, EGEE
- IBM, Oracle, Open Grid Forum

DATA SHEET:

Institution:	University of Edinburgh	Institute/ Group Name:	Institute for Digital Communications (IDCOM)		
Main Contact:	Bernard Mulgrew	Institute/ Group Size			
Group webpage http://www.see.ed.ac.uk/research/IDCOM/		Academic Researchers	14	Academic Staff	12
		PG Students	40		

Strategic Vision Statement (200 words max.):

To perform basic and strategic research:

- in digital signal processing and its application to communications, radar, audio and medical systems;
- in future systems and services for automated telephone services and advanced Internet services.

Research Themes (provide a brief summary title for each theme and give the key lead contact(s)):

- **Communications Systems** Prof Stephen McLaughlin
- **Signal Processing** Prof Bernard Mulgrew
- **Centre for Communication Interface Research** Prof Mervyn Jack

Key Research Highlights over last 5 years (these might include journal papers, awards, patents, spinout activity, etc. Please be selective, if necessary choose the top 10):

- 1) Of particular note is the fundamental work on modelling of multiple input multiple output (MIMO) radio channels and the exploration of 3-D MIMO arrays performed under Mobile-VCE.
- 2) A core activity is cross-layer optimisation within a range of communication systems. Within the Mobile-VCE the focus is on delivering efficiency to reduce the cost-per-bit; with Samsung the focus has been on resource management in ad-hoc and relay based communication systems resulting in 5 patent applications in the last three years; and with Toshiba on cross-layer adaptation in WLAN systems with 3 patents produced.
- 3) Collaboration with Lucent-Bell on MIMO systems has led to 2 paper prizes and 3 patents while a long standing relationship with Nortel continues to influence their products
- 4) Fundamental work on impulsive noise on copper access communications systems in collaboration with BT and Deutsche Telecom have led to its inclusion in the ETSI standard and take up by BT
- 5) In a programme funded jointly by EPSRC, BAE SYSTEMS and Qinetiq we successfully refuted the high profile Puthussery/Haykin conjecture

that sea clutter was an example of a chaotic process.

- 6) We were identified by BAE SYSTEMS as a Strategic Partner in Signal and Information Systems, funding a 6 person team and endowing the BAE/RAEng Research Chair in Multisensor Signal Processing; 3-year extension of Chair arrangement now agreed with SELEX S&AS.
- 7) We were the only group over the period to hold an EPSRC Platform Grant in Signal Processing. Notable achievements from this were an invited paper on automated segmentation of motion picture images and the first paper in the world on independent component analysis (ICA) in multiplicative noise environments.
- 8) First demonstration of the use of system-initiated digressive sales proposals in automated telephone banking using speech recognition technology. Aspects of this now incorporated into aspects of Lloyds TSB customer facing service.
- 9) New approach to speech-enabled computer-assisted language learning to allow users to engage in dialogues with virtual agents. Patent, licensed to Conversatec Ltd.
- 10) Formation of the Edinburgh Research Partnership with Heriot-Watt University, with Joint Research Institute in Signal and Image Processing

Graduate Student Research Training (Please provide brief details of type of training provided, including current numbers of students as well as the typical number of advanced degrees (MPhil & DPhil) awarded annually):

MSc in Communications and Signal Processing – 40 students per annum
PhD's in Communications and Signal Processing – 12 students per annum
EngD in Communications and Signal Processing – 2 per annum

Funding ('Current' Research Income , including sources):

EPSRC: £1.72M
EU: £1.0M
Industry: £9.78M

Total: £12.5M

Key Collaborators: Academic and non academic, including overseas:

Heriot Watt University, Bristol University, Surrey, King's College, Queen's University Belfast, Carleton University (Ottawa)

Nortel, Toshiba, LG, Lucent-Bell, Samsung, Lloyds TSB, Barclays Bank plc, BAE SYSTEMS, Selex S&AS, BT, Qinetiq, British Geological Survey

DATA SHEET:

Institution:	University of Edinburgh	Institute/ Group Name:	Integrated Micro and Nano Systems (IMNS)		
Main Contact:	Alan Murray	Institute/ Group Size			
Group webpage http://www.see.ed.ac.uk/research/IMNS/		Academic Researchers	40	Academic Staff	15
		PG Students	25		

Strategic Vision Statement (200 words max.):

IMNS works across a broad research front, from digital and mixed-mode System-on-Chip (SoC) design via novel computation on silicon to Micro-Electro Mechanical Systems (MEMS) design and technology. IMNS members often work in “cross-over” areas, where design meets technology, where many of the most interesting research challenges exist. This also allows IMNS to work in areas that are beyond the immediate industrial horizons, addressing questions that will promote new products and techniques over a 5-10 year timescale. As a result, IMNS’ research has been drawn increasingly towards the interface with medicine and life sciences. Our combination of design, computation and technology expertise, almost-unique in the UK, is ideal for this field and IMNS’ policy is to foster and to grow this form of research. IMNS research ranges from long-term strategic work to industrially-focussed product and technique development.

Research Themes (provide a brief summary title for each theme and give the key lead contact(s)):**System-on-Chip Design and Applications**

Prof. Tughrul Arslan

Novel (Largely Neuromorphic) Computation on Silicon

Prof Alan Murray

Imaging and bio-imaging on Silicon

Dr. David Renshaw)

Silicon Fabrication, MEMS and bio-MEMS

Prof Anthony Walton

Integrated RF Communication and Remote Sensing/Actuation

Dr. Brian Flynn

Key Research Highlights over last 5 years (these might include journal papers, awards, patents, spinout activity, etc. Please be selective, if necessary choose the top 10):

1. Spinout of Spiral Gateway (SoC start-up company)
2. Several patents underpinning (1) above

3. Development of CMOS Single Photon Avalanche Photodiodes (SPADS) for fluorescence lifetime detection – unpublished as yet.
4. Development of technology to release drugs into the body under RF power and control (several papers – journal and conference)
5. The first ElectroWetting Of Dielectric (EWOD) arrays on silicon, with CMOS drive circuitry
6. Demonstration of the ability of spiking computation to achieve auto-calibration of CMOS process mismatch (several publications, journal and conference)
7. Development of a stochastic neural architecture that allows accurate computation using inaccurate and noisy nano-scale transistors (several publications and a major eScience project).
8. Launch of ESPACENET : Evolvable Networks Of Intelligent And Secure Integrated And Distributed Reconfigurable System-On-Chip Sensor Nodes For Aerospace Based Monitoring And Diagnostics.
9. Development of 450 and 850nm Transition Edge Sensor (TES) world class bolometer arrays for the James Clerk Maxwell telescope in Hawaii (several papers – journal and conference).
10. Formation of the Edinburgh Research Partnership with Heriot-Watt University, via the cross-university “Institute for Integrated Systems”.

Graduate Student Research Training:

PhD, M.Sc. – typically 10/annum and 3/annum respectively.

Funding ('Current' Research Income , including sources):

Research Awards – 7,121,382

Example awards:

£727000 PPARC
 £449134 Scottish Enterprise
 £4,500,762 EPSRC
 £110000 University of Stirling
 £28869 Qiniteq
 £30000 BAE Systems
 £643076 Senju
 £72725 Applied Materials
 £37000 Spiral Gateway
 £279835 DTI
 £242981 Wellcome Trust

Key Collaborators: Academic and non academic, including overseas:

(Selective list as exemplars) : Universities of Glasgow, Heriot-Watt, Manchester, York, Sunderland, Aberdeen, Institute for System Level Integration Ltd., Surrey Satellite Technology Ltd. (SSTL), NASA Jet Propulsion Laboratory (USA), Epson Scotland Design Centre, Spiral Gateway Ltd., BA, GEC Marconi, ICI, Pilkington Optoelectronics, Spectron Laser Systems, Ocean Power Delivery, Senju Pharmaceuticals.