U.K. Neuroinformatics Network
Summary of Questionnaire Findings

Dr Kit Longden

July 10, 2005

Contents

Introduction

The aims of the questionnaire have been twofold:

1. To gather information in advance of the first open workshop, for the benefit of attendees of the first open call workshop;

2. To ensure that the views of members of the wider neuroinformatics, neuroscience and related communities can be represented by the network.

Methods

Interviews with 12 researchers from the neuroinformatics and neuroscience communities were used to formulate a questionnaire. The questionnaire was sent cold to 75 members of the wider neuroinformatics and neuroscience community. Personalised letters with the questionnaire were sent to 60 researchers, from which 18 written responses were collected. Particular care was taken to target: (1) experimental neuroscientists; (2) principal investigators or lab leaders; (3) female researchers; (4) members of the systems biology, e-science, integrative physiology, cognitive systems, machine learning communities; (5) the full panoply of U.K. geographical locations; (6) members of organisations involved in fostering links between academic and commercial partners; (7) clinical researchers.

Summaries of the interview accounts and questionnaire responses were used to identify common themes and unusual points. These are collated in the summary of findings. Where possible in the summary, views are represented by named quotes. The non-verbatim written accounts of the interviews have been checked by the interviewees, but are nonetheless reproduced as text, since the phrasings are not the interviewees' own. Where permission has been granted only for anonymous quotes, this has been used. Where permission to quote has not been given, responses have not been used.

Questionnaire

Q1) How can computational expertise best serve the neuroscience community?

Q2) How can neuroinformatics benefit from the current interest in computational biology, systems biology, integrative physiology, cognitive systems, or e-science?

Q3) Which research topics are well suited to UK collaborative ventures in neuroinformatics? Which are suited to international ventures?

Please tell us how you made your choices, for example,

- Strong UK expertise?
- Well posed data for computational inference?
- Future growth area?

Q4) How could commercial involvement usefully be increased?

Q5) How can the emerging national neuroinformatics networks recommended by the OECD best interact at the international level? For background to this question please see our website, http://www.neuroinformatics.org.uk.

Q6) How would neuroinformatics best be funded by the research councils? Current examples of funding schemes include:

- Fellowships (eg, MRC special training fellowships)
- Conventional response mode grants
- Cross-council initiatives (eg, Life Sciences Interface)
- EU and International schemes (eg, Human Frontiers Science Program)

Q7) What information and skills do people from the maths/physics/computer/engineering sciences need to work on problems in neuroscience?

Q8) How should the Network website be organised to best serve the community?

Q9) Please mention any other issues which you feel are important and that the Network could address.

Executive Summary

1 *Benefits of computational expertise for neuroscience*

- Modelling: for data prediction, system dynamics, conceptual frameworks
- Data analysis: e.g. multiple spike trains, integrative imaging
- Data handling tools: immediate benefits for imaging, with later benefits for neuroscience in general

2 *Benefits of computational/systems biology, escience for neuroinformatics?*

- Algorithms and data handling
- There is a large conceptual overlap, but a low research overlap

3 *Hot topics*

- Topics: Brain connectivity, Cortical processing, Data analysis, Decision-making, Development, Imaging analysis, Neural coding
- There was (in general) a lack of discussion about scientific, clinical or commercial justifications for choices

4 *Increasing commercial involvement*

- Through highlighting the socio-economic benefits of neuroinformatics methods and technologies e.g. for drug prediction, predictive medicine, commercial decision making
- Basic science is not commercial

5 *Mechanisms for international interactions*

- European focus
- Scientific meetings

6 *Funding*

- Fellowships are very important because they promote lab experience and basic training, and they co-localise skills
- Cross-council grants have the potential to unite skills not co-present locally, but their effectiveness is questioned
- A simpler European scheme is desired

7 *Skills*

- Basic training is seen as essential, but over a large range of disciplines reflecting research areas
- Lab knowledge is essential

- Lab presence is very important, in addition to lab knowledge

8 *Website*

- Support for resources, particularly facilitating communication between potential collaborators

9 *Other issues*

- Measures of success for the network should be put in place now, eg impact on funding and scientific progress
- Definition of neuroinformatics needs reinforcing eg through detailed examples

Summary of Findings

Question 1 *How can computational expertise best serve the neuroscience community?*

- Modelling

  Cited by many responders from a variety of backgrounds: Bogacz, Dayan, Eglen, Girolami, Juusola, Rolls, Sengpiel, Silver. "This entails biophysical and neuronal models of the systems that generate data sequences (from EEG through to fMRI)" (Friston). "...The goal always should be to be able to make useful predictions about the behavior of real biological systems" (Anon). "...Modelling, either as an integral part of an experiment or as a post-hoc analytic procedure" (Moore). "The complexities of architecture coupled with non-linear dynamics makes it impossible to 'think one's way' through the dynamic processing of systems, microcircuits and even individual neurone activity" (Redgrave). Modelling allows you to make predictions about the dynamics of your system (Juusola).

- Conceptual framework

  "By offering a crisp way to formulate the information processing problems that brains face..." (Dayan). "Critically, there is another fundamental contribution that neuroinformatics can make: this is in forming the generative models themselves by applying appropriate constraints on the basis of empirical data and suggesting models with particular algorithmic architectures" (Friston).

- Data analysis

  Again, cited by many responders from a variety of backgrounds: Eglen, Girolami, Silver, Dayan, Sengpiel, Rolls. "...The most important developments...have used ideas, algorithms and formulations, developed in the information processing community or machine-learning

community, for theoretical neuroscience and data analysis" (Friston). "...Methods for data analysis, especially of complex data such as simultaneous recordings from multiple neurons" (Anon).

- Technologies for large data sets

  Dayan, Eglen, Girolami, Silver, Somogyi. "Software design and development (mainly for controlling experiments)" (Moore). "...Need for high performance computing facilities to test computational models..." with large data sets in real time, requiring parallelised algorithms and computational expertise (Rolls). "Hardware - development of GRID systems for data/processor sharing; Software - relational databasing to include imaging and other "rich" data types" (Bullmore). "Network support" (Moore). Security of multiple-format imaging data is a high priority (Harding & Berry).

- Databases

  Databases of experimental data and of computational models with information for the experimentalist (Tolhurst). A major problem is the lack of available data (Edgley). There is an under-appreciated need to involve: engineers and software engineers; libraries, journals, and data curators; database groups (Cannon).

- Appreciated benefits

  Computational methods were understood to have clear (sometimes unspecified) benefits by many experimental neuroscience respondents. Examples include: "All aspects of science need computational expertise and providing this should be investigator led" (Somogyi); "All of these 'systems' issues naturally favor a more computational approach and neuroscience is concerned with the most complex and important biological system of all - so it should be easy for people to see the relevance of neuroinformatics in this context" (Bullmore). "By developing promising new approaches whose importance is recognised by the majority of biologists working in these fields" (Laughlin).

- Proof of concept

  "It would probably be helpful to strengthen the association between neuroinformatics and systems neuroscience perhaps by advertising clear examples of where an NI approach has yielded real benefits in terms of understanding brain systems" (Bullmore). It is difficult to know about the work of potential collaborators when the range of methods covers many disciplines. Many biologists find advanced mathematics/engineering hard to understand, and vice versa (Edgley).

Question 2 *How can neuroinformatics benefit from the current interest in computational biology, systems biology, integrative physiology, cognitive systems, or e-science?*

- Technologies

  "Algorithms and data handling" (Eglen). Data handling and processing (Silver).

- Overlap

  Respondents noted the overlap in the subject areas, in methods (Dayan) and problems (Bogacz, Friston). "Clearly there are many parallels with neuroinformatics and bioinformatics in that both have seen a rise in the development of experimental technologies which produce data at rates and volumes requiring sophisticated statistical computation" (Girolami).

- Lack of interaction

  Despite the noted overlap in potential research areas, a web survey established that the research areas of research groups in systems biology, computational biology and e-science had little overlap and interaction with neuroinformatics groups. The exceptions were recently appointed staff with background in neuroinformatics fields.

Question 3 *Which research topics are well suited to UK collaborative ventures in neuroinformatics? Which are suited to international ventures?*

- Development

  Suggested by development and non-development neuroscientists alike Eglen, Sengpiel, Tolhurst and Schultz. Development is a UK strength, with a large amount of data, but the field has remained highly qualitative (Tolhurst).

- Imaging topics

  "Brain connectivity..a growth area with computational input" (Bullmore). "...Structural imaging of the brain and pathway tracing, based again on MRI" (Moore). "...The integration of different measurement modalities" (Friston).

- Technologies & methods

  "UK appears to be strong in research groups working on problem solving environments and virtual organisations (e.g. Cardiff, Manchester, Southampton)" (Anon). "Neurophysiological data analysis" (Petersen).

- Other areas:

  Neural coding (Petersen), reinforcement learning (Bogacz, Redgrave), action selection (Redgrave), decision-making (Bogacz), Cortical processing (Sengpiel), Vision science (Tolhurst), auditory function (Anon), Spike train analysis techniques (Dyball). Three tractable areas with opportunities for multilevel analysis: Circadian rhythms, Hormonal control of neural systems controlling endocrine events, and Osmotic regulation (Dyball). Drosophila because [of the] complex behaviour [and the] genetic tools (Juusola).

- Global neuroscience

  "Neuroscience is extremely global" (Dayan). "The more international our scope is, the better" (Somogyi). The focus for your subject should be international (Sengpiel).

- Local imaging science

  "I do not see any need for any international collaboration with these initiatives. In many respects the UK has the sufficient intellectual and computational resources to meet this challenge" (Friston). "...I feel that local ventures are generally more likely to succeed than international ones. ...UK has a strong international lead" (Moore). "...Well suited to a UK or European collaborative venture (most of the leaders are not US-based)" (Bullmore).

Question 4 *How could commercial involvement usefully be increased?*

- Proof of concept

  Bullmore, Moore, Somogyi. "Need to demonstrate value of NI-based approaches in supporting commercial decision making" (Bullmore). Development of models and analytical techniques with clinical, pharmaceutical, biomedical applications i.e. of social and economic benefit" (Laughlin).

- Predictive neuroscience

  Bullmore, Eglen, Girolami. "In medical research, scanning is increasingly used as a diagnostic tool, but use of functional scanning and scanning for cognitive problems (e.g. mental health, dementia) hasn't really started" (Moore).

- Basic science is not commercial

  "Most research is still basic science. I can't see much useful scope for commercial involvement, except at the margins of things like novel algorithms, etc" (Dayan). "In fact, our distribution of academic software has, I think, been a key factor in developing scientific interest and collaborations in neuroimaging that would have been confounded by commercial involvement" (Friston).

- Translational research

  "It might be helpful to have some contacts within the NHS ...for discussions about transitioning research results to medical practice" (Anon). "Flexible, context-driven action selection that can be modified on the basis of experience is the holy grail of modern multifunctional systems" (Redgrave).

Question 5 *How can the emerging national neuroinformatics networks recommended by the OECD best interact at the international level? For background to this question please see our website, http://www.neuroinformatics.org.uk.*

- European focus

  " It would be difficult to avoid large amounts of administration with an international network. However, a European network could avoid this problem" (Silver). " Links to established US consortia (Human Brain Project, Neuroscience Blueprint, BIRN etc) are obviously important. I would also favor a more European focus" (Bullmore).

- Scientific meetings

  "Through international workshops" (Friston). International network could provide "network meetings, fellowships and grants for members to interact" (Eglen).

- International Neuroinformatics Network

  "...Most (though certainly not all) effective collaborations in science happen in a rather bottom-up manner - with a relatively small number of people getting together with a compelling mutual need." When the collaborations are organised in top-down fashion, the risk is that "...contributors (for instance neuroimagers) will not participate (for instance, wanting to keep their data proprietary for as long as possible). In bioinformatics, there are already many examples of successful international consortia, and so coordination might make sense. In neuroinformatics, bar some EU things, there aren't really, so there's little evidence for 'pull' for coordination" (Anon).

- Many respondents did not address this question.

Question 6 *How would neuroinformatics best be funded by the research councils? Current examples of funding schemes include:*

- *Fellowships (eg, MRC special training fellowships)*
- *Conventional response mode grants*
- *Cross-council initiatives (eg, Life Sciences Interface)*
- *EU and International schemes (eg, Human Frontiers Science Program)*

- Fellowships

  Skill-transfer fellowships are particularly important (Dayan, Friston, Moore, Redgrave), if "creatively designed" (Bullmore). "Training Fellowships are preferable because they invest in people who want to make a go of collaboration..." and demonstrate the necessary real commitment to collaboration required for combining theory and experiment in the challenging areas (Laughlin). "What is needed is funding for a large number of small scale projects such as the placements of a PhD student or a postdoc in a lab who interact on a daily basis with the PI" (Dyball).

- Response mode grants

  "Response mode grants without restriction of who the applicants can be and with individual responsibility are most const effective"

(Somogyi). "It would be very helpful to have more cross-council or conventional response mode initiatives aimed specifically at neuroinformatics research. Otherwise, grants for this kind of interdisciplinary research are at a disadvantage, because the subject matter often doesn't fit well into the standard grant schemes" (Anon). "...Competing with existing schemes and programmes. Neuroinformatics is a tool and must be seen in the context of driving scientific questions" (Moore).

- Cross-council initiatives

  "Since expertise is spread around the country, it might also benefit particularly from cross-institutional funding opportunities" (Petersen). Foresight was unsuccessful in that it simply put computational and experimental scientists in a room together (Tolhurst). "Cross-council initiatives are very sweet but do not do very much in practice" (Friston). "There is too much emphasis on large initiatives. ...Grand schemes often become unproductive and it is difficult to modify them to produce something useful" (Dyball).

- Europe & worldwide

  "The EU funding mechanism is badly broken" (Dayan). European schemes involve too much paperwork, so a European initiative would be welcome (Silver, Tolhurst). HFSP is almost unique: some other international scheme "...would be great" and "need to be supplemented somehow" (Dayan). "EU and international schemes are superficially attractive but entail too much bureaucracy to be effective" (Friston). "...Huge grandiose schemes are in my view less likely to be productive" (Redgrave).

- Other

  Fellowships in which computational and experimental labs share a postdoc (Tolhurst). Funding schemes for software development (Cannon). Lots of short-term start-up funding, facilitating traveling and communication would be really useful in establishing what collaborations will work: the partners can then take it from there with conventional funding schemes (Tolhurst).

Question 7 *What information and skills do people from the maths/physics/computer/engineering sciences need to work on problems in neuroscience?*

- Ability to listen

  Harding & Berry, Laughlin, van Rossum. "An ability to listen and learn so as to see the problem from the experimentalist's perspective" (Laughlin).

- Ability to accept unreliable data

  Bogacz, Moore, Anon.

- Training in biological sciences

  Training in: biology (Laughlin, Anon), frontier biology (Somogyi), basic neuroscience (Juusola, Moore), advanced neuroscience (Dayan), cell physiology (Anon, Dyball), basic neurobiology (Dyball). Knowledge of system being worked on (Eglen).

- Lab Experience

  Practical expertise (Dayan). To communicate with experimenters (Bogacz). Data collection from neurons is difficult and requires considerable expertise (Edgley). Experimental component of PhD programs (Bogacz). "Interaction with biologists and psychologists educated in neuroscience (e.g. through MSc courses)" (Moore). "Computational neuroscientists need ...experience in an experimental lab" (Juusola).

- Lab presence

  The most fruitful interactions between computational and experimental scientists are when the computational scientists are working in the lab, or are local (Sengpiel). If computational scientists are present in the lab or at least local, they can be at hand to say what is possible and what the benefits are. It is difficult to know in the experimental lab if computational expertise in a particular given situation will be useful. This is true whether the outcome from applying computational methods is short term progress or a long term collaboration (Tolhurst). "...A successful collaboration ...must involve a real back-and-forth discussion about the experimental constraints and the theoretical/computational issues" (Anon). "Engage directly with neuroscientists throughout all stages of their research" (Moore). "...What is needed in my experience is for labs to be set up where biologists and physical scientists have to interact with each other on a daily basis" (Redgrave). On fragmented campuses, the interaction is often correspondingly low (Tolhurst). To understand how techniques are evolving (Juusola). "[Computational expertise can best serve the neuroscience community] By being integrated with experiments" (Laughlin). "What is needed is ...the placements of a PhD student or a postdoc in a lab who interact on a daily basis with the PI" (Dyball).

- Education

  Students: There is a sharp divide in the teaching of biological and computational courses. There needs to be more undergraduate courses that combine these courses, or cross these disciplines (Edgley).
  Researchers: "We must, therefore, try to to break down barriers and educate each other so as to prevent people defining and practising narrow approaches that ultimately prove to be tangential" (Laughlin).

Question 8 *How should the Network website be organised to best serve the community?*

- Resource

  "Enhanced portal functions and opportunities for collaborative document or project development eg wikis" (Bullmore). Information about funding (Harding & Berry, Redgrave). (Map of) UK neuroinformatics groups (Bogacz, Redgrave). NHS & pharma contacts for translational research (Anon).

- Irrelevant

  "I never have time to browse websites" (Laughlin). Most respondents did not address this question.

Question 9 *Please mention any other issues which you feel are important and that the Network could address.*

- Measures of success

  "...Measures should be set up from the start that can be evaluated in three years time to see what difference it made" (Somogyi). The network needs to demonstrate that it can improve access to funding (Sengpiel). "The network will be successful if it increases access to funding [and] if it gets a number of small independent groups to work together" (Dyball).

- Definition of Neuroinformatics

  "I am never quite sure what are the boundaries of 'neuroinformatics"' (Dayan). The network needs to have a clear message about the scope of neuroinformatics (Silver). "However, people are not always clear what neuroinformatics is" (Bullmore). "Describing the scope of neuroinformatics by means of more detailed examples, so that biologists can see the scope of the computing involvement in real and artificial neural systems and computer scientists can see the scope of the biological areas of neurophysiology, nerve development, brain research, etc" (Anon).

- Funding forum

  "A forum to discuss the best way forward to get cross disciplinary grant applications appropriately assessed" (Redgrave).

- Imaging network

  The MRI community has an effective network, but there is scope and a need for a national imaging network (Harding & Berry).

List of Respondents

Written (18)

Dr Rafal Bogacz *Department of Computer Science, University of Bristol.*
Prof Ed Bullmore *Director Brain Mapping Unit, University of Cambridge.*
Dr Adrian Carpenter *Director of MRI & Computing, Wolfson Brain Imaging Centre, University of Cambridge.*
Prof Peter Dayan *Director Gatsby Computational Neuroscience Unit, University College London.*
Dr Stephen Eglen *Computational Biology Institute, University of Cambridge.*
Prof Karl Friston *Director Functional Imaging Laboratory, University College London.*
Dr Mark Girolami *Bioinformatics Research Centre, University of Glasgow.*
Prof Peter Holmans *Biostatistics & Bioinformatics Unit Chair, Cardiff University.*
Prof Simon Laughlin *Department of Zoology, University of Cambridge.*
Dr Jennifer Linden *Centre for Auditory Research, University College London.*
Dr Gos Micklem *Director Computational Biology Institute, University of Cambridge.*
Prof David Moore *Director MRC Institute of Hearing Research (IHR), Nottingham.*
Dr Rasmus Petersen *Division of Neuroscience, Manchester.*
Prof Peter Redgrave *Department of Psychology, University of Sheffield.*
Prof Edmund Rolls *Department of Experimental Psychology, University of Oxford.*
Prof Wolfram Schultz *Department of Anatomy, University of Cambridge*
Prof Peter Somogyi *Director MRC Anatomical Neuropharmacology Unit, University of Oxford.*
Dr Guy Williams *Assistant Director of Information Processing, Wolfson Brain Imaging Centre, University of Cambridge.*

Interview (12)

Mr Dave Berry *System administrator, Wolfson Brain Imaging Centre, University of Cambridge*
Dr Robert Cannon *Institute for Adaptive and Neural Computation, University of Edinburgh*
Dr Richard Dyball *Department of Anatomy, University of Cambridge*
Dr Steve Edgley *Department of Anatomy, University of Cambridge*
Dr Sally Harding *MR physicist Wolfson Brain Imaging Centre, University of Cambridge*
Dr Mikko Juusola *Department of Zoology, University of Cambridge*

Dr Andrew Polkington *Institute for Adaptive and Neural Computation, University of Edinburgh*
Dr Mark van Rossum *Director Neuroinformatics Doctoral Training Centre, University of Edinburgh*
Dr Frank Sengpiel *Neuroscience Research Group, Cardiff University*
Dr Angus Silver *Department of Physiology, University College London*
Dr Amos Storkey *Machine Learning Group, University of Edinburgh*
Dr David Tolhurst *Department of Physiology, University of Cambridge*