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Research Role Profile

Job Title:	Research Fellow A: Research Fellow in Neuromorphic and Quantum-Inspired Computing: Foundations and Applications in Wireless Communications

Responsible to:	Head of research group, or principal investigator

Responsible for:	Not applicable

Job Summary and Purpose:
To undertake research in accordance with the specified research project(s) under the supervision of the principal investigator.

Main Responsibilities/Activities
To undertake a range of research activities within a specified research area, assuming responsibility for specific areas of projects and making use of new research techniques and methods, in consultation with the research award holder or supervisor. This may include fieldwork, interviews, laboratory experimentation, critical evaluation and interpretation, computer-based data analysis and evaluation or library research. Using initiative and creativity to identify areas for research develop new research methods and extend the research portfolio. Analysing and interpreting results of own research. Write up results and prepare papers for submission to appropriate journals and conferences, and other outputs as required and/or appropriate. Attend appropriate conferences for the purpose of disseminating research results of personal development. The post holder may also contribute to writing bids for research grants and will contribute to collaborative decision making with colleagues in areas of research. Continually to update knowledge and develop skills, and translate knowledge of advances in the area into research activity. To plan and manage own research activity in collaboration with others. To carry out administrative tasks associated with specified research funding, for example risk assessment of research activities, organisation of project meetings and documentation. Implementation of procedures required to ensure accurate and timely formal reporting and financial control. To contribute to teaching in the Faculty by carrying out student supervision and/or demonstrating within the post holder's area of expertise and under the direct guidance of a member of departmental academic staff, as appropriate. The post holder may occasionally be required to supervise more junior research staff.

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Person Specification
The post holder must have: A doctoral degree in a relevant discipline (although individuals who have almost completed a doctoral degree may be appointed). Consideration may also be given to individuals who do not hold a doctoral degree but have required skills based on a number of years' experience in specified / relevant fields The post holder will have authority over some aspects of project work and must be capable of providing academic judgement, offering original and creative thoughts and be able to interpret and analyse results.

Relationships and Contacts
Direct responsibility to the principal investigator or academic supervisor. The post holder may be asked to serve on a relevant Faculty committee. There may be additional reporting and liaison responsibilities to external funding bodies or sponsors. The post holder may work on original research tasks with colleagues in other institutions.

Special Requirements
To be available to participate in fieldwork as required by the specified research project

All staff are expected to:

- Positively support equality of opportunity and equity of treatment to colleagues and students in accordance with the University of Surrey Equal Opportunities policy.
- Help maintain a safe working environment by:
  - Attending training in Health and Safety requirements as necessary, both on appointment and as changes in duties and techniques demand
  - Following local codes of safe working practices and the University of Surrey Health and Safety Policy
- Undertake such other duties within the scope of the post as may be requested by your Manager.

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Addendum to Profile

Job Title:	**Research Fellow A in Neuromorphic and Quantum-Inspired Computing: Foundations and Applications in Wireless Communications**

Job Summary and Purpose:

<u>This information sheet should be read in conjunction with the accompanying generic Research Role Profile and will be used for shortlisting processes. More specifically the post holder will be expected to</u>:

The post holder will conduct original research into new computational representations and emerging computing paradigms, with a primary focus on neuromorphic computation, energy-based optimisation and their connections to quantum and quantum-inspired computing. The research will investigate how computationally intensive problems can be reformulated as networks of interacting elements, and how alternative solver dynamics and computational architectures can improve performance, latency, energy consumption and hardware efficiency.

Wireless physical-layer signal processing, including MIMO detection and channel decoding, will provide important initial use cases. The researcher will investigate mathematical mappings (including Ising/QUBO and graph-based formulations), network structure and connectivity, solver convergence, preprocessing and reconfiguration costs, and fair end-to-end comparisons with conventional approaches. Relevant quantum annealing and quantum-inspired optimisation techniques will be explored as complementary routes to solving related formulations. Analogue and mixed-signal implementations will be considered as secondary, collaborative research directions, with specialist analogue development led by other team members.

Main Responsibilities/Activities

The post holder will work within the Wireless Systems Lab at the Institute for Communication Systems (ICS), collaborating with researchers in PHY algorithms, analogue/silicon modelling, FPGA/software implementation and external academic and industrial partners.

More specifically, the post holder will be expected to:

- Conduct original research on neuromorphic computational principles and novel representations of signal processing and optimisation problems, going beyond the implementation of trained neural networks.
- Develop and analyse mathematical mappings into networks of local processing elements and weighted interactions, including Ising/QUBO, graph-based, tree-based and other suitable formulations.
- Investigate solver dynamics and optimisation approaches, including iterative, relaxation, spiking or energy-minimisation mechanisms, and assess convergence, solution quality, complexity and scalability.
- Explore connections between neuromorphic computing, quantum annealing and quantum-inspired optimisation, including problem encoding, embedding, connectivity, control and practical computational overheads.

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- Apply and evaluate proposed methods in demanding wireless PHY tasks, especially MIMO detection and channel decoding, while identifying potential applicability beyond communications.
- Develop simulation frameworks and reproducible benchmarks to compare alternative representations and solvers with established digital algorithms, accounting for accuracy, throughput, latency, energy and implementation resources.
- Investigate end-to-end efficiency, including representation construction, preprocessing, parameter loading, data movement, reconfiguration and integration with conventional processors.
- Collaborate with colleagues working on analogue, mixed-signal, FPGA and other hardware platforms to assess implementability and algorithm–architecture trade-offs; direct analogue circuit development is not the primary responsibility.
- Publish high-quality research, contribute to project reports and deliverables, engage with academic and industrial collaborators, and help identify new research and funding opportunities.
- Plan and manage assigned research activities and contribute, as appropriate, to postgraduate student support and wider group research activities.

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Person Specification

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Essential Criteria

- A PhD (awarded or near completion) in Computer Science, Electronic/Electrical Engineering, Physics, Applied Mathematics or a closely related discipline.
- Strong mathematical and analytical foundations in at least one of optimisation, computational modelling, dynamical systems, signal processing, graph-based methods or related areas.
- Demonstrated research ability to formulate computational problems, develop novel algorithms or representations, and rigorously evaluate their properties.
- Knowledge of at least one relevant area, such as neuromorphic computing, energy-based optimisation, quantum-inspired algorithms, computational neuroscience, nonlinear dynamical systems or emerging computing architectures.
- Ability to analyse computational complexity, convergence or accuracy, and relevant latency, energy and scalability trade-offs.
- Strong programming and simulation skills in Python, MATLAB, C/C++ or equivalent, with the ability to develop reproducible computational experiments.
- Ability to work independently and collaboratively across disciplinary boundaries, and communicate research results effectively in writing and presentations.

Desirable Criteria

- Experience with Ising/QUBO formulations, combinatorial optimisation, energy-based models or graph/network representations of computational problems.
- Experience in neuromorphic algorithms, spiking or non-spiking network dynamics, event-driven processing, or specialised neuromorphic simulation platforms.
- Knowledge of quantum annealing, quantum optimisation or quantum-inspired methods, including mapping, embedding and limitations of practical solvers.
- Experience analysing nonlinear dynamical systems, coupled-network dynamics, convergence, stability or reconfiguration of computational networks.
- Experience in wireless PHY processing, particularly MIMO detection, channel decoding, estimation or related optimisation problems.
- Experience in algorithm–hardware co-design or evaluating parallelism, connectivity, memory movement, precision and hardware resource requirements.
- Familiarity with FPGA, GPU or other accelerated implementations and relevant development tools.
- Knowledge of analogue or mixed-signal computing, memristive systems or coupled oscillator networks, particularly for collaboration with specialist hardware researchers.
- A track record of high-quality peer-reviewed publications and experience in collaborative or externally funded research projects.