Bioinformatics Research

The University of Aberdeen

Bioinformatics research at the University of Aberdeen is focused on the rapidly growing field of systems biology, supporting interdisciplinary interactions between researchers in the biological, medical and physical sciences.

The underlying goal of systems biology at the University of Aberdeen is the development of mathematical models that predictively inform experimentation across a range of biological and medically-relevant systems. The rapid growth of systems biology at the University is evident from significant success in attracting UK funding agency support.

"The University of Aberdeen's innovative approach to systems biology research successfully deploys a range of modelling expertise in the physical sciences to facilitate rapid progress in biological research."

A specific Research Programme in Systems Biology has been developed at the University of Aberdeen; this program promotes systems biology through regular meetings and seminars and brings together world-class researchers with strengths in areas as diverse as microbial physiology, neuroscience, cell and developmental biology, human physiology, and environmental science. These scientists work closely with specialists in applied dynamics, computing, and engineering, to develop models of complex biological and disease processes. This programme is structured to flexibly accommodate researchers from across the physical and biological sciences and actively encourages the formation of interdisciplinary teams essential for productive application of systems biology methodologies. These unique collaborations ensure that systems biology helps underpin numerous strands of life sciences and medical sciences research.

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Modelling biological systems across a range of scales

Research teams at the University of Aberdeen are working in multidisciplinary groups with colleagues from the Schools of Natural Science and Computing, and Engineering, for example to develop systems biology models of key aspects of microbial physiology. Research areas include the modelling of core cellular processes such as ribosomal translation of mRNAs, and the process of DNA replication along a chromosome strand. Other research seeks to model the component regulatory modules that make up different stress responses in fungal pathogens. Systems biology is being used to model specific responses and predict the outcome of regulatory mutations upon these responses. Research teams are also investigating bacterial ion channels and their role in stress responses in bacterial cells. A principal research objective is to understand, via molecular analysis and predictive modelling, how ionic homeostasis is controlled in bacteria and its role in stress responses during pathogenesis.

The principles that underpin the model of a system operating at the cell and molecular scale are also being very successfully applied to modelling continental-scale processes such as carbon and nitrogen flux through atmosphere, biomass and soils. Ecosystem modelling can inform agricultural options to mitigate climate change and lead to better understand of feedback between elemental cycles and climate.

Systems biology approaches are also being applied to a broad span of other research, ranging from studies of control networks in the nervous system, to modelling of chaotic advection patterns in arterial blood flow, the latter leading to better understanding of cardiac artery blockage. This range of systems biology projects underscores the breadth of modelling expertise at the University of Aberdeen.

Modelling approaches; non-linear dynamics and model-based technology

Collaborations between biologists and engineers at Aberdeen are leading to the application of some novel technologies to model and predictively understand biological systems. Non-linear dynamics methodologies are being employed to develop deterministic as well as stochastic models of ***in vivo*** biology. Expertise in the modelling of non-linear systems is also being successfully deployed in understanding the impact of chaos on biological system behaviours. Model-based technology (MBT), encompassing Machine Learning and Qualitative Reasoning, is also employed in biological modelling, allowing researchers to understand the dynamic behaviour of a system without being restricted by the need to define its parameters. For example, MBT can be applied in the biomedical domain to the modelling and simulation of pharmacokinetic and metabolic systems. Qualitative Reasoning allows the use of sparse data to develop a representation of relationships between qualitative variables, often a useful first step in the development of a numerical model.

Vision for the Future

Bioinformatics at the University of Aberdeen, with its focus on systems biology, is rapidly expanding to generate an increasing number of integrated research teams from across a range of disciplines spanning the physical, medical and biological sciences. The flexible application of a number of modelling approaches, ranging from applied dynamics through stochastic to qualitative reasoning will allow swift progress in understanding of complex biological, medical and environmental systems.

"The modelling of complex stress responses in pathogens will lead to a greater understanding of the integration and processing of environmental cues by a microorganism in the host."

About The Scottish Bioinformatics Forum

The Scottish Bioinformatics Forum (SBF) was created for all developers and users of bioinformatics methods, and supports both the academic research base and commercial organisations by actively promoting training and facilitating access to bioinformatics skills. It is funded by the Scottish Executive, the Scottish Funding Council, and Scottish Enterprise.

www.sbforum.org

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