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Centres of Excellence in Research 2012–2017

The Centre of Excellence Programme 2012–2017 involves 15 Centres of Excellence (CoE) in Research, composed of research teams from a total of eleven universities and research institutes. Each CoE is coordinated by the university mentioned below.

Aaltonen, Lauri: Finnish CoE in Cancer Genetics Research

Cancer research in Finland is recognised as exceptionally high-quality. The field has an ambitious long-term target: to render meaningless the disease that is cancer through state-of-the-art gene technology and collaboration among leading experts from several disciplines.

Cancer is a disease involving two unique genomes – germline and that of the respective tumor. The rapid advances in genomic technologies are now enabling full genome analysis of individuals and cancers. The CoE is conducting genome-wide analyses in lines of research that are believed to hold the greatest promise. This is generating vast quantities of data as work is being done on up to a thousand samples at the same time.

At the CoE, this data flow is managed at two stages. First, using the tools of computer science, the unit performs sophisticated sequence analyses, sorting millions of sequence reads into an optimal order. This allows the researchers to identify real differences between samples from the background noise. Next, the systems biologists at the CoE set to work to find out which part of the variation has to do with tumour predisposition. Once the researchers have found an impression, they conduct searches in the Finnish Cancer Register in order to identify other similar patients.

If these studies uncover gene mutations that explain hereditary tumour susceptibility, the researchers will have at their disposal a predictive test. This will allow them to translate

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the findings into clinical tools to reduce cancer morbidity and mortality.

More information

Academy Professor Lauri Aaltonen, University of Helsinki

Sites of research: University of Helsinki, Finnish Cancer Register

Haapala, Pertti: The History of a Society: Rethinking Finland 1400-2000

The CoE studies the history of Finland from 1400 to the present day. The approach and the method used are a theory of the history of society, how society is constructed as functions, structures and identities. The mission is to research the construction of society and identities from a historical point of view and to find out how people form an understanding of their history.

The main goal is to contribute to a rethinking of the history of Finnish society, but the research interests are relevant to all countries and to modern nation states in particular.

The aim is also to redefine our historical understanding, and this has a close link with the perceptions and motivations of our time that are invoked both in daily life, education and politics. From an international research perspective, Finland is an interesting case to study major societal changes and so-called development premises.

More information

Professor Pertti Haapala, University of Tampere

Sites of research: University of Tampere, University of Jyväskylä, Åbo Akademi University

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Julin, Rauno: Finnish CoE in Nuclear and Accelerator-based Physics

Nearly all matter that surrounds us is held in nuclei of atoms, most of which are unstable. In all, there are around 8,000 possible species of nuclides, but no more than some 3,000 of them have so far been observed. The focus of the research at the CoE is on the structure of nuclei with extreme numbers of protons or neutrons (exotic nuclei).

The CoE is made up of four teams. At the Department of Physics of the University of Jyväskylä, the teams engage in experimental and theoretical research in nuclear physics and work to develop practical applications using accelerator technology and ion beams.

At the CoE, two teams are conducting experimental research into the behaviour of nuclear ground states and excited states. The research is directly affiliated with research in nuclear astrophysics. One of the teams works to develop ion beams and new applications for them in materials and biophysics. The CoE also involves a theory group that cooperates with the other teams with a view to interpreting the research results.

The CoE uses state-of-the-art equipment, including three accelerators and the university's Accelerator Laboratory, a large-scale, international-level infrastructure for experimental and theoretical studies operating in connection with the university.

More information

Professor Rauno Julin, University of Jyväskylä

Site of research: University of Jyväskylä

Kaski, Samuel: Finnish CoE in Computational Inference Research

The main specialisation of the CoE is in computational inference, a discipline that falls in the middle ground between computer science, data analysis and statistics. More and more often today, research in different fields draws on existing datasets, and it is crucial to

know how to identify and extract information that is relevant to end-users. This trend is most clearly evident in biomedicine and molecular biology. The CoE conducts computational methods research, where one of the key resources is adequate computational and data storage capacity.

The aim is to create and introduce methods and tools that help transform large data loads into useful information. The research is based on data-intensive computing modelling and inference on a large scale: how data should be modelled to make it possible to identify the essential in large datasets.

The CoE is a pioneer in the development of increasingly powerful computational inference methods for application in systems biology and medicine. Another important field of application is the development of new types of interfaces that can be used on the move to search for real-time information about items in the environment.

The CoE comprises seven research teams from Aalto University and the University of Helsinki. The CoE works closely with groups both at home and abroad, and attaches special priority to the training of young researchers.

More information
Professor Samuel Kaski, Aalto University

Sites of research: Aalto University, University of Helsinki

Kivinen, Markku: Finnish CoE in Russian Studies - Choices of Russian Modernisation

After the collapse of the Soviet Union, Russia has been forced to create a new identity as a state and nation. The country has had to build a new political, social and economic system in the midst of the rapidly changing European and global order.

The CoE is researching Russian modernisation, which is understood as alternative choices defined by certain structural premises. The frameworks, concepts and theories of

the differentiated scientific disciplines can produce only an insufficient analysis of Russia's contradictory development, whereas "the Finnish school", evolving within the CoE, can provide a new multi- and interdisciplinary research paradigm for an analysis of Russia's modernisation. At the same time, it will open a new perspective on the key issues in the relations between Russia and the European Union.

The CoE will be exploring Russia's modernisation from multiple angles – at the macro, meso and micro level, as well as from a historical viewpoint. Specific concerns at the macro level include changes in the political, social and economic system, while the focus at the micro level will be on consumers and entrepreneurs, for instance. In other words, the CoE's research agenda covers Russia as a whole, from major issues to small details, from past to future.

Common features in the CoE's approach are specific research questions and theoretical and methodological bases. Besides generating scientific results, the CoE also opens new perspectives on informed policy-making both in Finland and Russia and even internationally.

More information
Professor Markku Kivinen, University of Helsinki

Sites of research: University of Helsinki (Aleksanteri Institute), University of Tampere

Knip, Mikael: Finnish CoE in Molecular Systems Immunology and Physiology Research

Comprehending living organisms in the contexts of coordinated gene and molecular function and translating this knowledge into better human health is a great challenge and one of the central aims of medical systems biology.

The CoE comprises five research teams and is highly interdisciplinary and translational, covering competencies from clinical immunology and cohort studies to molecular systems immunology, metabolomics, diagnostics and computational systems biology.

The objective is to understand the molecular mechanisms that control the immune system as well as the interactions between the immune system and other physiological systems in health and disease. With this knowledge, the CoE hopes to create novel treatment and prevention strategies for inflammatory or immune-mediated disorders.

In the CoE, valuable and unique clinical resources such as the Finnish Type 1 Diabetes Prediction and Prevention study are integrated with state-of-the-art systems biology and immunology and cutting-edge research infrastructure.

More information
Professor Mikael Knip, University of Helsinki

Sites of research: University of Helsinki, University of Turku, Aalto University, Hospital District of Southwest Finland

Lassas, Matti: Finnish CoE in Inverse Problems Research

The exact natural sciences are all based on solutions to inverse problems: their foundation lies in inferences drawn from experimental knowledge and interpretations of that knowledge within the frame of mathematical models. The CoE engages in multidisciplinary research that ranges from the results of pure mathematics to industrial and commercial applications. This is made possible by applications of mathematical formalism.

The aim is to produce workable and well-reasoned solutions to practical inverse problems. This serves to demonstrate the power of mathematical methods with the phenomenal accumulation and growing complexity of experimental knowledge and mathematical models.

The problems addressed by the CoE include medical and industrial imaging, asteroid modelling, new-generation radar measurements, biomass and carbon footprint

measurements, and practical invisibility techniques. The CoE is the world-leading unit in the theory, practice and applications of inversion problems.

Based at six universities, the CoE teams make up an integrated and interactive network in the fields of mathematics, physics, statistics and computational science. For the teams, research is a way of life, a passion and an adventure.

More information

Professor Matti Lassas, University of Helsinki

Sites of research: University of Helsinki, University of Jyväskylä, University of Oulu, University of Eastern Finland, Tampere University of Technology, Lappeenranta University of Technology

Leskelä, Markku: Finnish CoE in Atomic Layer Deposition (ALD)

The CoE is committed to chemistry research and development, with special focus on the manufacture of ultra-thin films using the Atomic Layer Deposition (ALD) method. Major applications for ALD films are found in the field of microelectronics, nanotechnology and the energy sector.

The CoE comprises the Thin film Group at the University of Helsinki Laboratory of Inorganic Chemistry; the Materials Physics Division at the University of Helsinki Department of Physics; and VTT Microsystems and Nanoelectronics. Each team has its own primary area of expertise and its own tasks. The CoE is extensively networked both nationally and internationally, and works closely with industrial partners.

The aim is to develop new ALD processes for materials that are used in various microelectronics components, such as memories and microelectromechanical systems (MEMS), nanostructure solar panels and lithium-ion batteries and various optical and optoelectronic components.

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The CoE has a world-leading position in the development of ALD processes. This has been achieved with long and pioneering research. The added value of the CoE originates from a unique combination of excellence in the fields of chemistry, physics and electronics.

More information

Professor Markku Leskelä, University of Helsinki

Sites of research: University of Helsinki, VTT Technical Research Centre of Finland

Mappes, Johanna: Finnish CoE in Biological Interactions Research

The research focus of the CoE is on events occurring between different organisms and between different individuals of the same species. The big questions are often the same regardless of whether studying, for instance, plants, fungi, insects, bacteria, humans or complete ecosystems.

These interactions can be based on either cooperation or competition, and may entail predator-prey or host-parasite interactions, or social interactions within a single species. Surprisingly often there are conflicts of interest between different levels of organisations, individuals and populations.

A comprehensive and in-depth study of biological interactions requires a common frame of reference. For the CoE, that frame of reference is natural selection, which occurs at all levels of life.

The CoE is researching these interactions in ecologically realistic settings, across several trophic and selection levels and covering the organism selection ranging from viruses to vertebrates. This will provide a more in-depth understanding of the interactions and conditions that either help different organisms adapt to the changing environment or inevitably lead to their extinction.

Biological questions in nature conservation and the major environmental problems of our day are ultimately outcomes of conflicts of interest. That is why it is important to make people aware of behavioural models that date back to prehistoric times.

More information

Academy Professor Johanna Mappes, University of Jyväskylä,

Sites of research: University of Jyväskylä, University of Helsinki

Mäki, Uskali: Finnish CoE in the Philosophy of the Social Sciences

The focus of the CoE's research is on the changing practices of knowledge production and interdisciplinary dynamics in its contemporary settings. Among the main targets are interdisciplinary relations within the social sciences and between them and other fields, such as cognitive neuroscience and evolutionary biology. Through empirical case studies the CoE examines the conceptual frameworks, methods and models used in these disciplines. Further, it seeks to understand their similarities, differences and interactions by way of an analysis of their intellectual toolboxes.

The aim is to understand and improve the practices of knowledge production by identifying and analysing strategic concepts, arguments and debates. By studying interdisciplinary encounters as well as the lack of interdisciplinary connections, the CoE aspires to contribute to building bridges between different disciplines more generally.

The research team consists of devoted philosophers of science and scholars of the ontology of social reality, all world-class experts in their respective fields.

More information

Academy Professor Uskali Mäki, University of Helsinki

Site of research: University of Helsinki

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Ovaskainen, Otso: Finnish CoE in Metapopulation Research

The CoE in Metapopulation Research at the University of Helsinki is internationally well known for its research into ecological, genetic and evolutionary consequences of habitat fragmentation. This field of research is called metapopulation biology. A habitat involving a great number of different organisms is naturally fragmented but man's land use has also increased the fragmentation of living environments of many other species. The results generated by metapopulation biology research are therefore significant for the protection of species and habitats, and for land-use planning as well.

The CoE carries out both theoretical and empirical studies, and many individual projects are based on mathematical models that can be tested with material collected from natural populations. Many of the research projects also apply research methods from molecular biology and genetics.

The mission of the CoE is to create new knowledge and understanding of how the spacial structure of the environment affects the dynamics of natural populations. The CoE combines ecological and molecular genetic research and genome-level research. The aim is to understand the biology of natural populations from the molecular level through to the population.

More information

Professor Otso Ovaskainen, University of Helsinki

Site of research: University of Helsinki

Pekola, Jukka: Finnish CoE in Low Temperature Quantum Phenomena and Devices

The CoE's mission is to investigate quantum phenomena at low temperatures and to identify possible applications. Some of the research faculty work at temperatures very close to absolute zero to study such low temperature phenomena as superfluids.

At low temperatures, physical systems eventually condense into their quantum mechanical ground state and may exhibit extraordinary properties not known in everyday contexts. Known examples include the superconducting state of metals where the electric current flows lossless, and the superfluid state of helium, in which the flow is lossless. Both cases are examples of macroscopic quantum-mechanical phenomena that occur in low temperatures.

Another increasingly important research focus in this field includes phenomena in nanostructures. Work at the CoE concentrates on the area of nanoelectronics where quantum phenomena are significant.

More specifically, research at the CoE includes charge and heat transfer and related fluctuations, and mechanical motion governed by quantum mechanics. The materials studied by the CoE include helium superfluids, superconductors, graphene and carbon nanotubes as well as ordinary metals.

More information
Professor Jukka Pekola, Aalto University

Sites of research: Aalto University, VTT Technical Research Centre of Finland

Pihlajaniemi, Taina: Finnish CoE in Cell-Extracellular Matrix Research

The extracellular matrix has many crucial roles to play. In order to gain a true picture of how the human organism works, we need to consider the constant interaction between cells and the extracellular matrix.

The CoE’s aim is to understand the dialogue that goes on between cells and the extracellular matrix, a process that is necessary for the formation and normal function of organs and blood vessels, as well as in cancers and other types of diseases. The CoE is also interested to explore the functions of stem cells in the processes of renewal and

differentiation. The new understanding gained from these studies will lead to improved diagnostics and treatments during the next few years.

The extracellular matrix is not just a support structure but an extremely diverse and active agent. It works at once as a messenger and as a regulator of disease processes. The extracellular matrix provides behaviour cues to cells, and creates a physical barrier to the progression of cancer.

One of the CoE's visions is to be able to grow replacement organs from individual cells. The number of kidney patients, for instance, far outstrips the number of donors.

The CoE's aim is to conduct research that will help identify mechanisms of malignant cell transformation and ultimately lead to new diagnostic methods and treatments. We want to facilitate the detection of cancer and treatment before the disease progresses too far.

More information
Professor Taina Pihlajaniemi, University of Oulu

Site of research: University of Oulu

Sorjonen Marja-Leena: Finnish CoE in Intersubjectivity in Interaction

The CoE's research focus is intersubjectivity, the achievements and maintenance of mutual understanding in the context of human interaction. The CoE is home to a multilingual and multidisciplinary community of researchers specialising in linguistics, social sciences and speech science. The common denominator in the work is ethnomethodological conversation analysis. In addition, the CoE applies the tools of interactional linguistics, construction grammar, psycho-physiological methods and the study of gestures.

Much of the research is handwork. The main research method applied is conversation

analysis, that is, to specify the ways in which mutual understanding is achieved through construction, identification and interpretation of actions and sequences of actions. Another research focus is on how the structures of language have gradually evolved to serve mutual understanding. Making comparisons is the key issue in studies of mutual understanding in language contacts.

Using the CoE's extensive collections of audio and video recordings of different types of interaction situations, the aim is to find answers to three main questions: First, the CoE is interested in how mutual understanding is reached in interaction through the construction, identification and interpretation of actions and sequences of actions. Second, the aim is to describe in detail how structures of language support the achievement of mutual understanding among the parties to interaction. The third area of focus is the role of emotions in social interaction. The main focus is on Finnish and Finland Swedish.

More information

Professor Marja-Leena Sorjonen, University of Helsinki

Site of research: University of Helsinki

Törmä, Päivi: Finnish CoE in Computational Nanoscience

Nature itself has chosen to operate on the nanoscale when creating the functional structures necessary for the maintenance of life. This is why the new materials arising out of nanoscience research will contribute to meeting the biggest challenges faced by humankind.

The CoE is focused on researching and understanding structures and systems at the atom and molecule level from a materials physics point of view. This is a fascinating field of study that comprises a rich variety of phenomena and that constantly brings up surprises in the shape of new discoveries.

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Nanoscience has paved the way to a synthesis of several branches of natural sciences, with physicists, chemists, biologists and materials scientists all working on the same research problems. Common areas of interests range from DNA molecules to electronics materials.

The mission is to harness the methods of nanoscale research to find answers to the major issues facing humankind, which include securing the energy supply, water cleanliness, environmental protection, novel information technologies and advanced medical treatments. Catalysis research is one of the areas that bring us close to raw materials and chemical industry. Apart from basic research interests, a major motivation for the CoE's work comes from the needs of society.

More information

Professor Päivi Törmä, Aalto University

Sites of research: Aalto University, Tampere University of Technology