UNIVERSITY OF LEEDS

CANDIDATE BRIEF

Research Fellow in Computational Cardiovascular Flows, Mechanics & Devices
Faculty of Engineering & Physical Sciences (up to 2 posts)

Salary: Grade 7 (£33,797 – £40,322 p.a.)

Reference: EPSCP1029

Closing date: 14 February 2021

Fixed-term until 31 October 2022

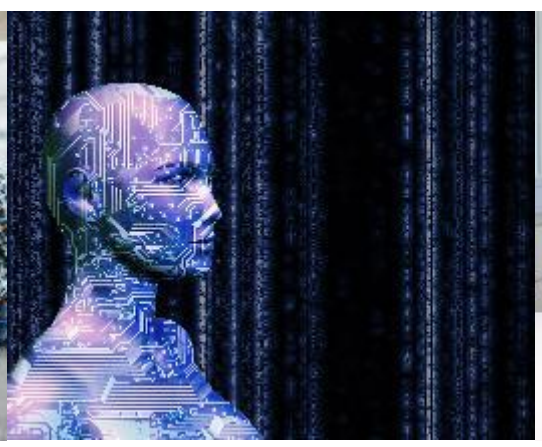
We will consider flexible working arrangements

Research Fellow in Computational Cardiovascular Flows, Mechanics & Devices (up to 2 posts),
School of Computing.

Are you an early- or mid-career researcher who wants to set the theoretical foundations that solve clinical and industrial problems? Do you have a background in computer vision, medical image computing, machine and deep learning, biomedical engineering or computational multi-physics and multi-scale modelling? Are you willing to take up the challenge to working across disciplines and on real-world data? Are you passionate for combining computational algorithms, modelling and simulation in trailblazing research to create virtual patient populations and deliver in-silico trials in medical devices?

The Centre for Computational Imaging and Simulation Technologies in Biomedicine (CISTIB), within the Faculties of Engineering & Physical Sciences and Medicine & Health, involves various academics and their research groups. CISTIB focuses on algorithmic and applied research in the areas of computational imaging, machine learning, deep learning, and computational physiology modelling and simulation. CISTIB works in close cooperation with clinicians from various research centres from the University of Leeds and the academic hospitals of the Leeds Teaching Hospitals NHS Trust, one of the largest NHS Trusts in the UK. CISTIB is part of the Centres' conglomerate conforming the broader Leeds Centre for Responsive HealthTech Innovation in response to the recent Government Leeds City Region Science & Innovation Audit recognising the regional industrial R&D focus on MedTech.

CISTIB hosts a Royal Academy Chair in Emerging Technologies (2019-2029) to deliver INSILEX, a 10-year programme to undertake trailblazing research in Computational Medicine and In Silico Trials. INSILEX envisions a paradigm shift in medical device (MD) innovation where quantitative sciences are exploited to engineer MD designs, explicitly optimise clinical outcome carefully, and thoroughly test side-effects before being marketed. In-silico trials are essentially computer-based MD trials performed on populations of virtual patients. They use computer models/simulations to conceive, develop and assess devices with the intended clinical outcome explicitly optimised from the outset (a-priori) instead of being tested on humans (a-posteriori). This will include testing for potential risks to patients (side-effects) exhaustively exploring MD failure modes and operational uncertainties in-silico, before testing in live clinical trials. Advanced computer modelling will prove useful to predict how a device behaves when deployed across the general population or when used in new scenarios


outreaching the primary prescriptions (device repurposing), helping to benefit the broadest possible target group without unintended consequences of side-effects and device interactions.

Within 10 years, we expect to have transformed MD design/evaluation by delivering these outcomes:

a) Minimise animal/human suffering by reducing, refining, and replacing animal/human testing.
b) Advance personalised treatment towards customised medical devices and precision medicine.
c) Develop medical devices optimised for robustness to uncertainty and lifestyle profiles.
d) Achieve a marked decrease in long-term device failures and an increase in beneficial patient outcomes.
e) Improve cost-effectiveness by quicker execution at a fraction of the cost of a full-scale live trial.

We are looking for Research Fellows supporting our work to address three main challenges we identified:

1) Build Virtual Patient Populations using probabilistic modelling;
2) Model device-tissue interactions through multi-physics, physiological modelling;
3) Develop efficient schemes to run ensembles of virtual experiments through accelerated numerical solvers and physics-informed machine learning. We identified cardiovascular medical devices as the first exemplar scenario (e.g. vascular stents, grafts and coils, valvular prostheses, etc.).

You can undertake innovative and high-impact research in one of the above areas:

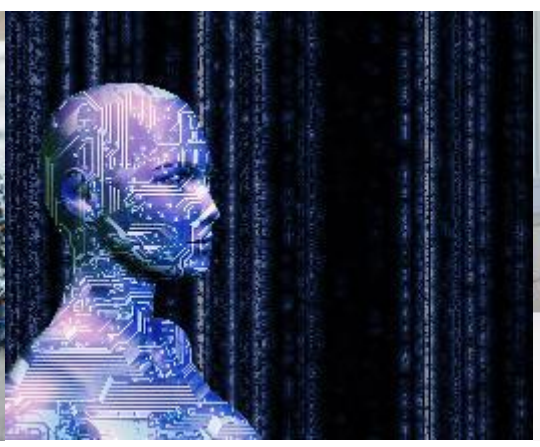
a) Deep learning for image analysis of cardiovascular population imaging (segmentation and modelling of cardiac chambers, valves, and vessels). These involve analysing datasets of several tens of thousands of images in an automatic manner; develop data harmonisation, image super-resolution, image imputation, generative image synthesis; and generative virtual population models.
b) Modelling long-term response and failure models due to host organ-device interaction. Developing surrogate models for predicting long-term patient outcomes from technical device outcome measures.
c) Develop computational fluid dynamics, computational mechanics, and computational physiology methods accelerated using, amongst others, reduced-order models and physics-informed neural networks.



Responsibilities will include developing new mathematical approaches to cardiovascular image analysis and computational physiology in the research areas outlined above; developing software implementation of these approaches in MULTI-X (www.multi-x.org), and communicating the research internally within the group, to external partners, and to the broader scientific community through journal publications and conference presentations. Using your knowledge of machine/deep learning, image analysis and computation, you will develop methods for highly automated and robust construction of image-based models of the cardiovascular system for subsequent multi-physics simulation of physiology. You will make technical and scientific contributions in line with the scientific goals of the underpinning projects from where the post draws its funding.

Research Fellows are academic researchers who can work independently, or as part of a research team, under the scientific leadership of a senior academic. Research Fellows have a strong academic profile including publication in top-rank peer-reviewed journals and conferences, excellent research enterprise and scholarship skills to conceive and pursue ground-breaking research questions, and they are able to manage graduate students and resources effectively setting direction, goals, a work plan, and monitoring progress. They are excellent problem solvers and are abreast of the advances in their field. They can serve as external liaison and maintain a network of local and external collaborators as required to deliver their goals.

You will hold a BSc/MSc (or equivalent) degree in relevant areas (i.e. physics, engineering, computer sciences, mathematics, or statistics), and a PhD (or thesis submitted and pending viva within 2 months) in a relevant computational domain. A track record in research commensurate with level of experience; in depth knowledge in statistics, physics, machine learning, and/or engineering and maths in the broad sense; excellent communication skills (oral and written); proficiency in computer programming (Python is a must as well as proficiency in at least MATLAB, C/C++ or other major programming language); knowledge on deep learning environments (TensorFlow, Keras, and PyTorch) and GPU optimisation; ability to work independently, meet deadlines, take critique constructively, and excellent analytical skills are essential. Experience in medical imaging physics and analysis (e.g. MRI, CT, and US), and a good knowledge in statistics and/or Bayesian learning would be advantageous.


What does the role entail?

As a Research Fellow, your main duties will include:

- Develop novel deep learning algorithms for computational medical imaging and modelling of the cardiovascular system; develop robust methods applicable to real-world and large-scale medical imaging databases;
- Develop physics-informed machine/deep learning for accelerating multi-physics and multiscale simulation of fluid flows, tissue deformation, electrophysiology, and blood clotting;
- Developing deep learning-based workflows to go from medical image analysis to computational simulations through automatic mesh generation and setting boundary and initial conditions to facilitate in-silico trials of medical devices;
- Writing and disseminating results of the research amongst project collaborators, and among the wider scientific community via publications in peer-reviewed, high-impact scientific journals and presentations at national and international scientific conferences; our minimum standard is two journal publications a year as first author;
- Support CISTIB academics to prepare proposals and grant applications to external bodies in your area of expertise. Prior experience with preparing grant applications would be advantageous;
- Participate in and coordinate group activities such as seminars, team meetings, weekly reporting, public engagement, and dissemination activities;
- Continuously update your knowledge in your area of expertise and aligned to the scientific programme needs by undertaking training and personal development as required;
- Take ownership of own career development in line with the Researcher Development Framework (RDF) through our Reflection & Development process.
- Take responsibility in project management and periodic reporting relating to INSILEX programme;
- Contribute to and take ownership in maintaining CISTIB's software repository.

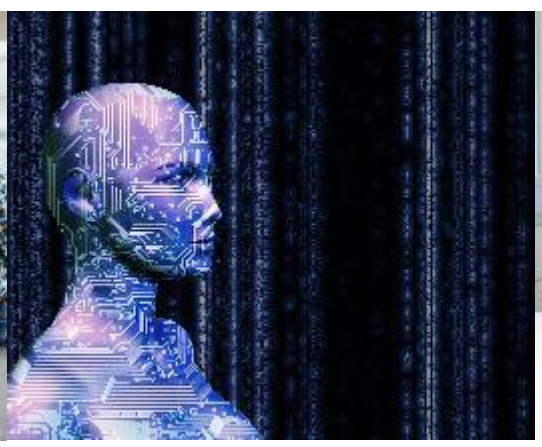
These duties provide a framework for the role and should not be regarded as a definitive list. Other reasonable duties may be required consistent with the grade of the post.



What will you bring to the role?

As a Research Fellow, you will have:

- A BSc/MSc (or equivalent) degree in relevant areas (i.e. physics, engineering, computer sciences, mathematics, or statistics);
- A PhD (or equivalent degree, or thesis submitted and pending viva within 2 months) in a relevant area: computer science, electrical engineering, physics, mechanical engineering, biomedical engineering, statistics, mathematics or related fields;
- Proficiency in programming for scientific computing with Python. Knowledge in at least a major programming language like C/C++ and MATLAB. Knowledge in numerical, statistical, and scientific computing libraries is a bonus. Strong software engineering skills for rapid and accurate algorithmic development. Demonstrable commitment to open and reproducible science;
- Solid background on finite element methods, physics-informed machine learning, scientific computing, fluid dynamics, computational mechanics;
- Thorough understanding on one of these domains and frameworks computational mechanics theory and experience with at least one common open/commercial solver: ANSYS Fluent or CFX, OpenFoam, etc. Experience in machine learning and common deep learning libraries will be a bonus (e.g. TensorFlow or PyTorch);
- Effective communication skills, with the ability to understand user requirements and communicate technical information to clinical partners, and to disseminate the research work and outcomes to both the scientific community and the wider scientific community;
- Ability to actively engage with clinical and industrial collaborators to better understand the clinical problems which motivate the research, and to ensure that the solutions developed are viable;
- Evidence of the ability to work effectively independently or within a multidisciplinary team, co-operating and participating effectively with others to achieve common objectives making distinct contributions, with the ability to confidently enquire, challenge and question, and sharing ideas openly;
- Experience of developing research projects, with the ability to see beyond immediate questions to unexplored areas, to monitor and evaluate progress, impact, and outcomes, and to plan and prioritise research activities;


- Excellent project management and time management skills, with the ability to establish own time management systems, prioritise work, deliver projects on schedule, and respond flexibly to changing situations;
- Evidence of a proactive, positive attitude to your own professional development and growth as a researcher, with a purposeful and determined focus on developing excellence in research, taking it from the ordinary to the extraordinary.

You may also have:

- Experience of co-supervising or assisting with postgraduate student projects.

How to apply

You can apply for this role online; more guidance can be found on our How to Apply information page. Applications should be submitted by 23.59 (UK time) on the advertised closing date.

Contact information

To explore the post further or for any queries you may have, please contact:

Professor Alex Frangi, Diamond Jubilee Chair of Computational Medicine
Email: a.frangi@leeds.ac.uk

Relevant References

Further readings on Computational Medicine & In Silico Trials.

- Abadi E, Segars WP, Tsui BMW, Kinahan PE, Bottenus N, Frangi AF, Maidment A, Lo J, Samei E. Virtual clinical trials in medical imaging: a review. J Med Imaging (Bellingham). 2020 Jul;7(4):042805.
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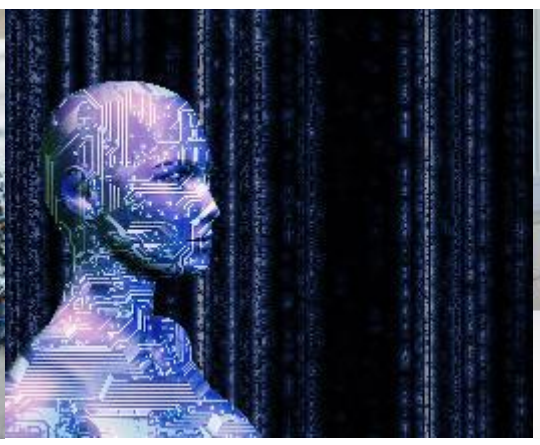
- Sarrami-Foroushani A, Lassila T, Frangi AF. Virtual endovascular treatment of intracranial aneurysms: models and uncertainty. Wiley Interdiscip Rev Syst Biol Med. 2017 Jul;9(4).

Additional information

Faculty and School Information
Further information is available on the research and teaching activities of the Faculty of Engineering & Physical Sciences and the School of Computing.

A Diverse Workforce
The Schools in the Faculty of Engineering & Physical Sciences are proud to have been awarded the Athena SWAN Bronze or Silver Award from the Equality Challenge Unit, the national body that promotes equality in the higher education sector. Our equality and inclusion webpage provides more information.


Working at Leeds
Find out more about the benefits of working at the University and what it is like to live and work in the Leeds area on our Working at Leeds information page.

Candidates with Disabilities
Information for candidates with disabilities, impairments or health conditions, including requesting alternative formats, can be found on our Accessibility information page or by contacting us at disclosure@leeds.ac.uk.

Please note: If you are not a British or Irish citizen, from 1 January 2021 you will require permission to work in the UK. This will normally be in the form of a visa but, if you are an EEA/Swiss citizen and resident in the UK before 31 December 2020, this may be your passport or status under the EU Settlement Scheme.

Criminal record information

Rehabilitation of Offenders Act 1974
A criminal record check is not required for this position. However, all applicants will be required to declare if they have any 'unspent' criminal offences, including those pending.

Any offer of appointment will be in accordance with our Criminal Records policy. You can find out more about required checks and declarations in our Criminal Records information page.