

Centre for Computational Imaging and Modelling in Medicine

Website Content

2024/04/11

Reviewer	Date	Overall comment
Jennifer	2024/04/11	An edited version of the Content Request document: - Added a Hero section (the top of the homepage, first thing visitors will see) - A simplified Mission section for the lay audience - Added graphics ideas (highlighted in green) Request for review sent.
Alex		

Hero Section:

Title:

Centre for Computational Imaging and Modelling in Medicine

Tagline:

Disruptive Science for Healthcare in the Digital Decade

Graphics:

- We can use interesting images from your research, either giving it some enhancing visual treatment or putting together a collage
- We can also use a short simulation video, but it may take a while to load when visitors arrive at your site, thus becoming less impactful
- We can also create an original illustration to represent your research and vision—since this option would take longer and be more pricey, I would only recommend this if you plan to use this illustration for other purposes, e.g. presentations, gifts for lab guests/members, etc.

Mission Statement:

At the heart of our mission is the ambition to revolutionise medicine through pioneering the science and adoption of computational medicine, computational phenomics and in silico trials.

Text box on the side:

Computational Medicine is a discipline devoted to the development of quantitative approaches for understanding the mechanisms, diagnosis, and treatment of human disease through applications of mathematics, engineering, and computational science.

- Prof Ray Winslow (link to <https://roux.northeastern.edu/people/raimond-winslow/>)

The problem:

Medical technology is developing so quickly that it has outpaced our ability to test for safety and efficacy, hence delaying benefits to patients and healthcare systems.

Graphics:

- An illustration showing the regulatory process as the bottleneck to bringing medical innovations to patients

The Opportunity:

Scientific evidence generated by computer-based trials (aka in silico trials) of medical products is poised to transform how health science research as well as regulations are conducted. It can reduce, refine, and partially replace the need for laboratory tests, animal experiments, and human clinical trials. This allows faster, safer, and more cost-effective medical innovations that benefit patients and improve economic growth.

UK can take a leadership position in in silico trials, which would cement its position as a global leader in health and life sciences, help drive the UK economy, and provide UK citizens with early access to innovative health products.

Graphics:

- Building on the previous image, this illustration will show in silico trials providing alternative, shorter paths from medical innovation to patients, getting around the regulatory bottleneck

Our approach:

Our work lies at the crossroads of medical image analysis and modelling with an emphasis on machine learning and computational physiology.

Through **Computational Medicine**, we advance healthcare by developing computational models of disease and personalising these models using complex, real-world patient data. By applying the models, we improve disease diagnosis and treatment as well as produce regulatory evidence of the safety and efficacy of medical products to tackle cardiovascular disease, musculoskeletal disorders, and cancer.

Graphics:

- An illustration showing the combination of medical image analysis, physiological modelling, and real-world patient data for developing computational models of disease that can be used to
 - discover novel risk biomarkers
 - predict disease progression
 - design optimal treatments
 - develop new medical devices

Description of lab expertise:

Expertise 1:

Image-based physiological modelling respecting physical and biological constraints and operating over multiple data sources, complex human anatomies, & multi-scale multi-physics problems

Expertise 2:

Advanced machine learning and deep learning over multi-modal, complex, and real-world datasets at scale to predict virtual outcomes and performance readouts of medical products as well as to accelerate mechanistic simulations of virtual medical interventions and examinations

Expertise 3:

Synthetic data and digital twins in healthcare to generate data-driven models of Virtual Patient Populations that represent meaningful variations of anatomy, physics, and physiology, and are consistent with the target real populations

Expertise 4:

Real world case studies with head-to-head comparison between conventional randomised controlled trials and in silico trials

Expertise 5:

International collaborative network of regulatory scientists from academia and industry

Expertise 6:

Commercial impact & success creating patents, spin-off companies, research contracts with various companies, and ongoing licensing

Graphics:

- Each expertise will be paired with a simple icon

Description of research themes:

Theme 1:

Population of Virtual Patients and Participants

Conceive a statistical modelling/inference framework to create data-driven anatomy, physiology, and pathology models that mimic anthropomorphic populations and are statistically well-characterised for in silico trials

Theme 2:

Device Modelling and Device-Tissue Interactions

Develop computational models of existing and novel medical implants and imaging systems. Develop computational mechanobiology models of device/organ interaction capable of predicting long-term response/failure modes

Theme 3:

Efficient Virtual Experiments

Build numerical schemes capable of highly efficient yet accurate massive ensemble simulations of patient physiology and patient/medical device interactions

Theme 4:

In-silico Clinical Trials

Deliver high-quality, hypotheses-led in silico trials that raise awareness and credibility of this new form of regulatory and scientific evidence. Conceive and realise the practical implementation of a modelling/simulation infrastructure for orchestrating scalable in-silico clinical trials.

Graphics:

- Each theme will be paired with a simple icon

Description of previous/current projects/grants

Project 1:

INSILEX: Computational Precision Medicine for In-Silico Trials of Medical Devices

(Royal Academy Chair in Emerging Technologies 2019-2029)

INSILEX envisions a paradigm shift in medical device innovation where quantitative sciences are exploited to carefully engineer medical device designs, explicitly optimise clinical outcomes, and thoroughly test side-effects before being marketed. Using a case study on flow diversion devices and coils for the endovascular treatment of haemorrhagic stroke, it lays computational foundations and evidence for accelerating the adoption of in-silico trials as an early and cost-effective source of scientific evidence.

Within 10 years, INSILEX will have transformed MD design/evaluation, delivering these expected outcomes:

- minimise animal/human suffering by reducing, refining, and replacing animal/human testing;
- advance personalised treatment towards customised medical devices and precision medicine;
- develop medical devices optimised for robustness to uncertainty and lifestyle profiles;
- achieve a marked decrease in long-term device failures and an increase in beneficial patient outcomes;
- improve cost-effectiveness by quicker execution at a fraction of the cost of a full-scale live trial.

Project 2:

INSILICO Hybrid Machine Learning for Virtual Chimaeras and In-Silico Trials: Cardiovascular Device Innovation & Regulatory Science

(European Research Council Advanced Grant / UK Research and Innovation Frontier Research Guarantee 2023-2028)

INSILICO will establish the first integrated framework combining data- and knowledge-driven machine learning, realising in-silico trials (ISTs) in medical devices (MDs). Novel in-silico insights on MD safety and efficacy will significantly impact regulatory science and innovation by reducing R&D costs and speeding up regulatory clearance.

This project will 1) introduce the concept of virtual chimaeras, 2) extend physics-informed learning over graph networks to construct new reliable, accurate and fast multiphysics simulators, and 3) re-enact a unique industry-provided trial dataset to grow trust in ISTs by industry, trialists and regulators. INSILICO will deliver the first head-to-head comparison between a Randomised Control Trial and an In Silico Trial, using a real-world dataset from an \$80m trial on cardiac prosthetic valves for heart failure.

Project 3:

InSilicoUK - A UK Centre of Excellence in in-silico Regulatory Science and Innovation supporting the Entire Product Lifecycle in Life and Health Sciences

(Innovate UK Regulatory Science and Innovation Networks, 2024)

Our project aims to establish a UK Centre of Excellence in in-silico Regulatory Science and Innovation in the Life Sciences (UK CEiRSI). Our Centre will establish the tools, standards, and best practices for integrating evidence from computational models into the regulatory process as a new source of information. The Discovery Phase will involve expanding partnerships, formalising the operating model, and engaging with regulators, compliance and standardisation bodies, and industry (building/expanding relationships). We will also focus on the drivers for regulatory trust based on ethical principles and public attitudes and conduct a skills gap analysis (complete background information and data gathering). To drive learnings and best practices for the next phase, we will define up to three in-silico mock submission challenges as concrete

demonstrative examples of using in-silico approaches in different aspects of the regulatory process (develop a proposal for the Implementation phase).

Graphics:

- A summary figure for each of these projects would be quite beneficial

Profiles of group members

Alex's Research Interest:

Professor Frangi's main research interests are at the interface of medical image analysis and modelling, emphasising machine learning (phenomenological models) and computational physiology (mechanistic models). He researches computational medical imaging and computational image-based medicine. He is interested in developing fundamental image analysis and modelling methods, medical image registration and reconstruction, statistical shape modelling, and machine-learning and deep-learning approaches to the previous goals. The broad goals of his research programme are:

- (i) to develop intelligent systems to deal with the analysis of large-scale complex and multimodal data where imaging plays a central role,
- (ii) to develop new approaches to integrate mechanistic and phenomenological imaging-linked models.

Professor Frangi is also interested in new approaches to incorporate models and priors into data-driven approaches to retain the benefits from their ability to deal with complex data while controlling their expressivity and making them practical in problems constrained by data availability. He is particularly interested in the statistical methods applied to population imaging and in-silico clinical trials. His highly interdisciplinary work has been translated into cardiology, osteoporosis, and neurology.

Alex's Biosketch:

Appointments

- Bicentennial Turing Chair in Computational Medicine at the University of Manchester, Manchester, UK (joint appointments at the Schools of Engineering and Health Sciences)
- Royal Academy of Engineering Chair in Emerging Technologies (Precision Computational Medicine for in silico trials of medical devices)
- Director of the [Christabel Pankhurst Institute](#) on health technology research and innovation at the University of Manchester
- Director of the Digital Infrastructure Team at the [NIHR Manchester Biomedical Research Centre](#)
- Honorary Chair, Katholieke Universiteit Leuven (2019–present)
- Turing Fellow, Alan Turing Institute (2019–2024)

Education/Academic qualification

- PhD, Three-dimensional model-based analysis of vascular and cardiac images, Imaging Sciences, Utrecht University, Utrecht, The Netherlands (1997–2001)
- BSc/MSc, Quantification and Noise Modelling in Electrical Impedance Tomography, Telecommunications Engineering, Universitat Politecnica de Catalunya, Barcelona, Spain (1991–1996)

Professional memberships

- EAMBES Fellow (2013)
- IEEE Fellow (2014)
- SPIE Fellow (2020)
- AAIA-AI Fellow (2021)
- MICCAI Fellow (2021)
- Turing Fellow (2021)
- FREng (2023)

Group members:

Use this [Google form](#) to collect group member profiles.

Academics:

- Ali Sarrami <a.sarrami@manchester.ac.uk>
- Arezoo Zakeri <arezoo.zakeri@manchester.ac.uk>



Professional platforms: LinkedIn: arezoo-zakeri

Research interest: My research focuses on developing AI-driven generative models to create virtual populations for in-silico trials.

One sentence of yourself: I enjoy cooking, walking, and gardening. I also love spending quality time with my kids and engaging in outdoor activities with them.

Postdoctoral Fellows:

- Haoran Dou <haoran.dou@manchester.ac.uk>



Professional platforms: Homepage: <https://wulalago.github.io/>

Research interest: My area of expertise is in artificial intelligence for in-silico clinical trials.

Specifically, I focus on the generative AI for virtual patient synthesis and treatment.

One sentence of yourself: ;)

- Fengming Lin



Professional platforms: LinkedIn: fengming-lin, Github: fmlinks, Email: sdulinfm@gmail.com

Research interest: My research focuses on Deep Learning for Medical Image Analysis.

Specifically, developing automatic pipeline for in-silico clinical trials.

One sentence of yourself: Golf handicap range from 12 to 30+.

- Michael Macrauld <michael.macrauld@manchester.ac.uk>



Professional platforms: X: @MichaelMacRaid, LinkedIn: michael-macrauld

Research interest: Using mathematical and computational modelling to solve in-silico trials problems.

One sentence of yourself: I love going on outdoor adventures, watching and playing football, and listening to all sorts of music.

- Yidan Xue <yidan.xue@manchester.ac.uk>



Professional platforms: X: @YidanXue, LinkedIn: yidan-xue, Homepage:

<https://yidanxue.github.io/>

Research interest: My research focuses on using mathematical models to study problems in biology and medicine, and developing in-silico trials.

One sentence of yourself: I love classical music, playing bridge, and video games.

PhD Students:

- Thomas Julian <thomas.julian@manchester.ac.uk>



Professional Platforms: LinkedIn: Thomas Julian, Google Scholar: Thomas Julian's Publications, X (formerly Twitter): @TomJulian18

Research Interests: I'm an academic ophthalmologist, currently focused on using artificial intelligence and images of the eye to predict and prevent major health events like heart attacks and strokes.

About Me: When I'm not working, you'll likely find me traveling to new places, soaking up the atmosphere at a music festival, or experimenting with new recipes in a cooking class.

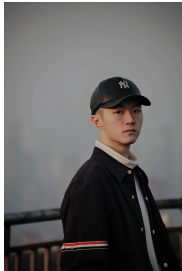
- Dibyakanti Kumar <dibyakanti.kumar@postgrad.manchester.ac.uk>

Professional platforms: LinkedIn : dibyakantik

Research interest: My research focuses on the theoretical aspects of complex optimization problems in deep learning, and I am very interested in applying these ideas to solve real-world problems in medical sciences.

One sentence of yourself: I enjoy exploring a variety of topics and watching in-depth video essays that dive deep into specific subjects during my free time.

- Zherui Zhou <zherui.zhou@postgrad.manchester.ac.uk>



Professional platforms: LinkedIn: zhou-zherui

Research interest: Virtual Population, Representation Learning, Generative Models

One sentence of yourself: I like music and video games. Also, any gym partners?

Alumni

- Name
- Photo
- Year of graduation
- Title and PDF of thesis
- Current position
- LinkedIn link

List of collaborators and partners

- Bernard Keavney <bernard.keavney@manchester.ac.uk>
- Anirbit Mukherjee <anirbit.mukherjee@manchester.ac.uk>
- Tingting Mu <Tingting.Mu@manchester.ac.uk>
- Omar Rivasplata <omar.rivasplata@manchester.ac.uk>
- Ajay bangalore Harish <ajay.harish@manchester.ac.uk>

- Seppo Virtanen <S.Virtanen@leeds.ac.uk>
- Alistair Revell <alistair.revell@manchester.ac.uk>
-

Our Principles

- Empowering Breakthroughs, Together— Highlights our Centre's collective effort and interdependence to achieve scientific excellence and impactful advancements in computational medicine (1).
- Focused Teams, Broad Impact— Emphasises our strategic organisation around small, accountable teams within our Centre pursuing a shared vision and dedicated to making focused breakthroughs and achieving significant, wide-ranging impacts across the centre and beyond (2).
- Excellence Through Credible Ideas— Reflects the group's commitment to creating a believability-weighted idea meritocracy, where the best ideas lead the way, regardless of their source (3).

1. Frangi, AF, et al. Unlocking the Power of Computational Modelling and Simulation Across the Product Lifecycle in Life Sciences: A UK Landscape Report. InSilicoUK Pro-Innovation Regulations Network, 2023, doi:10.5281/zenodo.8325274.
2. Wu L, Wang D, Evans JA. Large teams develop and small teams disrupt science and technology. Nature. 2019 Feb;566(7744): 378-382.
3. Dalio R. Principles: Life and Work, Simon & Schuster, 2017.