Developing the next generation of lung function measurement: A Study Group in Mathematical Modelling

Challenge Owners info pack

APRIL 17-20 2023

University of Sheffield
Co-organised by: BIOREME Network+, Insigneo Institute, and the Knowledge Transfer Network
Funded by the EPSRC

Who are we?

BIOREME (Integrating data-driven BIOphysical models into REspiratory MEdicine) is an EPSRC-funded Network+ connecting researchers, industry and patient representatives at the interface of mathematical modelling and respiratory medicine. You can find out more about our activities at www.bioreme.net.

Based at the University of Sheffield, the Insigneo Institute is Europe's largest research institute dedicated entirely to the development, validation, and use of in silico medicine technologies. Established in 2012, it has built a strong multidisciplinary network of over 260 academics and clinicians who bring together expertise in biomedical imaging, healthcare data, computational modelling, and digital healthcare technologies.

The Knowledge Transfer Network (KTN) was established by Innovate UK to connect innovators with partners and new opportunities. The Mathematical Sciences team within KTN harness the power of mathematics to meet business needs and help a wide range of industries express problems in an accessible way. They also facilitate new partnerships with an extensive network of mathematical scientists and institutions across the UK.

The BIOREME partner institutions:

What is a Study Group?

A Study Group is an intensive problem-solving workshop where participants; academics, PhD students, clinicians, companies, work together on specific research challenges or tasks. This study group "**Developing the next generation of lung function measurement**" will take a format similar to a *hackathon* whereby the participants choose which challenge they want to work on, brainstorm to propose potential solutions and then work together to progress these solutions as far as they can over the course of the next 3 days.

Why a study group?

The main goal of the study group is to provide an interface between companies, clinicians and mathematicians to develop mathematical tools to solve the problems presented. A study group is a fantastic opportunity to have dedicated academic expertise focusing on a challenge proposed by industry or clinicians. Academics work at the forefront of research, therefore enables access to the latest developments and theories. It is a great insight into how companies could potentially work with an academic team and a taster into what could be achieved over a longer project.

Who is it for?

Challenge Owners (Industry or clinicians presenting a research challenge) can either be industry representatives from companies with an interest in the relevant areas or clinicians/medical researchers working in respiratory medicine with a relevant research question.

Relevant Research areas

Challenges should be related to one or more of the following areas **lung imaging, lung function measurement, lung pathophysiology assessment, remote monitoring, breath content measurement, and breath biomarker discovery.**

If you are not sure whether your idea fits this criteria, feel free to contact us at contact@bioreme.net and we will be happy to discuss it with you.

Study Group Format

Challenge Owners will present their challenges and outline any accompanying datasets in the afternoon on Day 1. There will be a Q&A to ensure participants get a clear idea of the challenges and what is being asked. Following this, Challenge Owners are welcome to remain present for the following 3-day event and at minimum we ask they attend, either in person or virtually, the scheduled drop-in sessions and mid-way presentations to discuss progress and steer the group(s) working on their challenge. On the afternoon of the final day the teams will present their final progress on the challenges, Challenge Owners must attend this session in person.

Who are the participants?

The participants will be academic researchers (at least PhD candidate level or equivalent) from a range of backgrounds including statistical methods, biomechanics, biophysics, computational modelling, medical imaging and lung function/breath content measurement. We expect the majority of attendees to be Postgraduate Students or Early Career Post-Doctoral researchers. Whilst participants may not have specific experience in the real-world challenge presented, they will have the transferrable skills to tackle new challenges in their domain of expertise.

What can I expect (and not expect) to get out of it?

You can expect to benefit from:
- 3 days of dedicated researcher time working on your challenge
- A technical report summarizing the progress made on your challenge
- A new perspective on your challenge and a proposed solution method
- Opportunities to network with scientists who have expertise in your problem area and are open to new collaborations with industrial/clinical partners

Please do not expect:
- A complete and polished solution to the challenge
- Intellectual Property rights over the submitted reports and methods developed (this remains with the authors).

What is expected of me?

There is no monetary cost for Challenge Owners to participate however we expect you to:
- Dedicate time to work with the BIOREME team in advance of the workshop to refine your challenge (as detailed below in "Submitting a challenge")
- Attend the workshop in person on day 1 to present your challenge and partake in an initial Q and A
- Be available in person or online for subsequent drop-in sessions as indicated on the schedule to provide feedback to the participant groups
- Be available in person for the final presentations on Day 4
- Complete a survey within 6 months after the event to report any onward impacts generated from participating in this event e.g. Follow-on group forms around the challenge and direction discussed, scientific publications, new collaborations
- To acknowledge BIOREME in any activity following on directly from this workshop
- To read and approve a final technical report (where applicable)
- To allow BIOREME to develop and share case studies based on the submitted challenge and resultant impact
- To continue to engage with the BIOREME network (optional)

Submitting a Challenge

By submitting a challenge you agree that, if accepted, the challenge description will be published open access in the Study Group programme, which will be available online. Elements can be redacted for the online version in the case of reasonable concerns around data privacy or commercial sensitivity.

Timeline

31/01/22: Submission deadline
Submit your challenge here before 5pm (UK time) on 31st January 2023. Refer to "What makes a good Challenge" for guidelines on how to write your challenge.

01/02/23 – 20/02/23: Interviews/discussion
After an internal sift of challenges based on relevance and plausibility, applicants will be invited to an interview to outline the challenges in more detail and discuss potential alterations or modifications recommended by the sift panel.

28/02/23: Selection of challenges
Successful applicants will be informed that they have been selected as Challenge Owners.

01/03/23 – 19/03/23 Revision and refinement process
The Challenge Pack for the Study Group will be drafted and shared in an online document so that challenges can be refined in collaboration with the Challenge Owners based on the recommendations of the sift and selection panels.

What makes a good Challenge?

Guidance for writing and presenting your challenge

To be successful, a challenge will need to:

1. **Fall within the remit of this workshop:**

The challenge should be related to one or more of the following areas lung imaging, lung function measurement, remote monitoring, breath content measurement, and breath biomarker discovery.

2. **Be posed for mathematical/computational/data modelling experts**

The applications of the challenges will be varied as outlined above, but the main activity of the challenge will need to be mathematical, computational or statistical in nature.

3. **Be suitable in scope for a three-day workshop**

While we would not expect participants to reach a full solution after three days, the problem needs to be suitable in scale that significant and valuable progress could be reasonably expected in that time.

4. **Provide sufficient information and data for the challenge**

While there will no doubt be limitations to data that can be shared, sample or anonymized data that can be used to test possible solutions will be important to enable participants to reach satisfactory solutions.

Other factors to consider:

- **Participants will choose which challenge they work on, so make it attractive**
  - o Outline motivations and possible outcomes of addressing this challenge
  - o Highlight what makes it mathematically/scientifically challenging
- **Data sharing/ privacy/ ethics**
  - o Consider what data sets you will provide and whether you own or have the right to use the data sets

Example Challenges

Below we provide some example challenges with external links from previous Study Groups in different research areas to give an idea of the kind of problems that work well within the format. Some information has been redacted where requested by the organisers of the Study Group in question.

Example 1

Title: Secure Machine Learning for rare disease prediction
Authors: Mendelian
Source: Knowledge Transfer Network
Summary: Mendelian is a company that works to identify rare diseases earlier to the benefit of patients. They submitted a challenge to a Mathematical Study group with the aim to progress machine learning techniques for rare disease prediction whilst maintaining patient privacy. They provided anonymized patient data for ideation and proof of concept.

The full challenge can be found here.

Example 2

Title: Mathematical modelling of steroid responsiveness in severe asthma and COPD
Authors: Prof Ian Adcock (National Heart and Lung Institute, Imperial College London), Prof Yike Guo (Department of Computing, Imperial College London)
Study group: NC3Rs 2013
Summary: This challenge presented at the NC3Rs study group, 2013, concerned using mathematical modelling to help better understand the interconnected biological pathways in response to steroid use for asthma and COPD patients. By developing more accurate mathematical models, this work aimed to facilitate the development of fewer and more predictive animal models.

The full Challenge and outcome report can be found here:
https://mmsg.mathmos.net/uk/2013-nc3rs/steroids/

Example 3

Title: Represent the degree of mimicry between prosodic behaviour of speech between two or more people
Authors: ExpertoCrede
Source: The 107th European Study Group with Industry
Summary: This challenge was presented at the ESGI Study Group ran by The University of Manchester in 2015. The company Experto Crede wanted to better understand the impact that people communicating through devices eg. Telephone and text, has on human relations. To achieve this they wanted support in developing systems that could identify mimicry in words and prosody, to better put emotional response into context, to measure empathy, rapport and trust.

The full challenge can be found here

External links to databases of Mathematical Study Group Challenges in Industry

Mathematics in Industry – The International Study Groups website:
http://miis.maths.ox.ac.uk/information.html

Mathematics in Industry reports:
https://www.cambridge.org/engage/miir/public-dashboard

Mathematics in medicine study groups
https://mmsg.mathmos.net/