PhD Studentship
Department of Mechanical Engineering
University College London

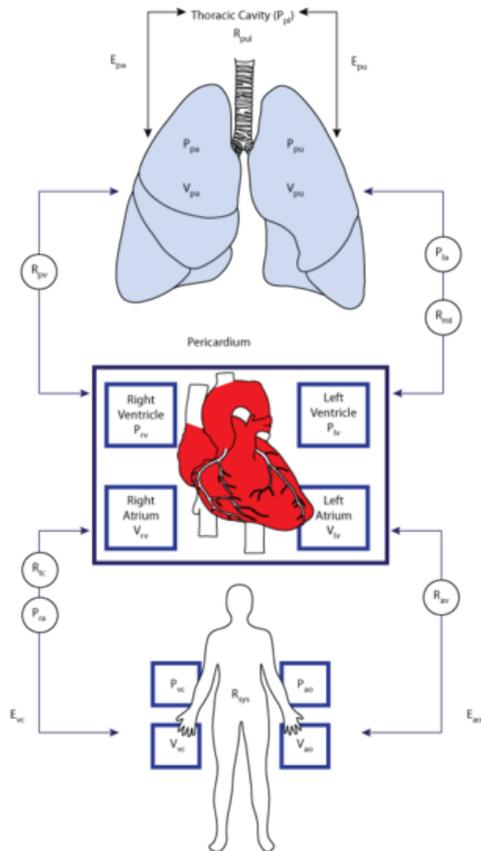### *PhD in Mechanistic, Physiological Models of Intensive Care Patients and Classification via Machine Learning*

Background:

This is an exciting opportunity since we are looking for a PhD studentship funded by the Department of Mechanical Engineering at UCL as part of CHIMERA project.

CHIMERA is one of four national Maths in Healthcare Hubs announced in March 2020. CHIMERA, which stands for **Collaborative Healthcare Innovation through Mathematics, EngineeRing and AI,** is a multidisciplinary Hub which brings together experts in mathematics, statistics, data science and machine learning, with unique, high volume and rich data sets from both adult and paediatric Intensive Care Units provided through embedded Project Partnerships with Great Ormond Street Hospital and University College London Hospitals.

The problem:

Each year about 20,000 children and 300,000 adults in the UK need intensive care. These critically ill patients are continuously monitored at the bedside, including measurements of heart rate, breathing rate, blood pressure and other vital sign data. The relationships between the internal physical state of the patient and external measurements are non-linear and contain multiple positive and negative feedback loops. Added to this, the external measurements are subject to interruption and artefacts. Finally, in most hospitals vital sign data are permanently recorded only every hour by manual entry into the patient record. Effectively, the wealth of information contained in the ICU vital sign data is largely wasted. Meanwhile, although many mathematical, biomechanical models of organs and circulation exist, it has mostly not been possible to test these using real time high frequency vital sign data and when this has been attempted, the models' predictivity has been weak as they were developed in isolation from the clinical data.

CHIMERA will deliver new mathematical frameworks combining artificial intelligence and coupled differential equations to learn the biophysical relationships that govern the interdependencies between physiological variables, based on data sets for thousands of patients through these project partners.

The PhD Project:

We will explore available data and review current literature as well as public-domain packages, e.g. to build mechanistic, physiological models relevant to ICU patients, focusing on breathing and cardiac performance.

During the project, we will then carefully consider model assumptions and we will analyse structural uncertainties for these models. We will then proceed to generate a 'cohort' of candidate models of varying complexity/structure for validation and selection. These models will be parametrised and validated using data already existing in partner hospitals.

For the best performing candidate models, much larger cohorts of virtual subjects will be established by varying the values of the clinically interesting parameters, overcoming the limitations of smaller cohorts. We will implement deep-learning architectures to classify patients using each candidate model and identify patients at greatest risk of a given event.

The at- risk patient types will be analysed further and compared via a similarity score. The clinicians will be explicitly consulted to see how/which of the risk classifications obtained might best assist clinical decision making.

Person specification:

Required Qualifications

- Have achieved (or are predicted) a first class or upper second class honours undergraduate degree (or equivalent international qualifications or experience). An MSc is also preferred, though not essential.
- Our preferred subject areas are Physical Sciences (Computer Science, Engineering, Mathematics and Physics) or any core Engineering discipline (e.g. Bioengineering/Biomedical Engineering, Mechanical Engineering, Chemical, Electrical Engineering, etc.). All applicants must be able to demonstrate strong mathematical skills.
- Strong programming skills in Matlab, Python, C++, Java or any other programming language.
- Experience in physiological modelling would be a plus.
- Applicants whose first language is not English are usually required to provide evidence of proficiency in English by UCL. Further details can be found on the following UCL web page

A Diverse and Inclusive Environment – We Work Flexibly too!:

We pride ourselves in being nurturing, open, diverse and inclusive and we believe in responsible research metrics. We fully support DORA and we believe in a working environment where we help individuals reach their full potential. We provide outstanding mentorship. We welcome applications from minoritized (underrepresented) groups in STEM disciplines and we are very flexible in the ways we work. If you have the passion and you are a good fit to the project, we want to hear from you!

World Class Science, Excellent Location and Experience:

The successful candidate will become part of HIMERA Hub at UCL and will benefit from a strong collaboration between computer science, mathematics and mechanical engineering as well as world-class expertise from clinicians. The PhD candidate will register at UCL Mechanical Engineering.

The successful candidate will benefit from a dynamic and world-class learning and working environment as part of the CHIMERA Hub, as part of the main UCL campus.

Start date: October 2020

Value of award: Successful applicants will be awarded a stipend of at least £17,280 (tax free stipend) as well as fully funded fees.

Eligibility: UK/EU applicants.

Application Procedure:

If you meet the requirements set above you can apply directly by e-mail to Professor Vanessa Diaz (v.diaz@ucl.ac.uk) with the following information:

- A recent CV
- The full transcript of exam results (listing all subjects and their corresponding grades/marks)
- A cover letter stating how this opportunity meets your research interests.

Individuals in their final year of study should list all modules/grades for which the results are already known.

Deadline: The process will be formally closed on the 20th of August 2020 but applications will be continuously assessed so we recommend to submit early.