About the project: Exploring cell/virus interaction with ABM

Observation by time-lapse imaging *in vitro* under a variety of controlled experimental conditions is an important technique in biology, for example to study the infection of host cells by viruses. However, such interactions are complex, which makes observation only partially satisfactory: something is observed to happen, but the circumstances that caused it happen are the subject of hypotheses.

The goal of this project is to advance research in the study of cell-virus interactions specifically, and biology theory and practice more generally, by building a composable simulation framework of agent-based models (ABMs) that can be configured to capture *in silico* the characteristics of *in vitro* experiments.

There are two approaches to bridging the the hypothesis/observation gap:

1. data-to-theory, which applies image processing to what can be observed through a microscope and then uses ML/statistics to extract behavioural patterns that support biological theories;
2. theory-to-data, which uses computational instantiations of biological theory behavioural models for entities to generate and match data, possibly in the form of visualizations, to observation.

Biological observations will be used as starting points and ground truth for parameterisation and testing of ABMs that describe virus infectivity. *In silico* results can then drive the next phase of the theory-to-data approach in which what-if simulation experiments help determine the *in vitro* experimentation agenda. Thus, theory and data reinforce one another in the study of naturally occurring interactions between cells and pathogens.

In addition to being reconfigurable, the simulation framework will need to be scalable, to support heterogenous populations of 100K or more entities. This will entail exploration of alternative computational approaches, and matching different elements of the framework to different kinds of computational resources, which may affect what may be composed with what. Related problems include modelling planar (2D) structures and 3D structures; regular grids, irregular meshes (e.g. Voronoi) and continuous structures; synchronous vs. asynchronous interaction; development and implementation of metrics; visualization tools; data augmentation, and synthetic data generation.

Candidate

Applications are invited for a funded 3-year PhD studentship in the University of Bath's Department of Computer Science, starting September 2022 (or earlier depending on candidate circumstances) under the supervision of Julian Padget (Computer Science) and Julia Sero (Biology & Biochemistry). Applicants should have strong interests in the interdisciplinary area of computational biology and will have freedom to steer the direction of the research towards their interests and strengths within the overall project description. Candidates must have a strong BSc (1st or 2:1) or Master's degree in Computer Science or related field. They must have excellent written and verbal communication skills in English, strong work ethic and the ability to think creatively and independently. Knowledge of machine learning, data analysis, modelling skills and some biology are desirable.

How to apply

Interested candidates are encouraged to contact either Julian Padget (j.a.padget@bath.ac.uk) or Julia Sero (j.sero@bath.ac.uk) before submitting an application, with a CV and a short paragraph about their research interests. A complete formal application must be submitted via Bath's online application portal (https://www.bath.ac.uk/study/pg/applications.pl). Applications will be considered until the position is filled. Please make reference to this project in your application.

Funding Notes

This particular PhD position is funded through the EPSRC Centre for Doctoral Training in Digital Entertainment, but is not tied to topics in the CDE's remit. The studentship (standard stipend, standard training support fee) is for 3 years, starting September 2022 (or earlier depending on candidate circumstances) and is only available to candidates that meet one of the following nationality and residence requirements: UK nationals that meet residency requirements; EU nationals with settled status; EU nationals with pre-settled status that meet residency requirements; Irish nationals living in UK or Ireland; those who have indefinite leave to remain or enter; none of the above but can demonstrate the means to pay the difference between home and overseas fees. Please do not apply if you do not meet one of these criteria.