2020 YCCSA SUMMER SCHOLARSHIP PROJECT SUBMISSION

This form is for prospective project supervisors to submit their projects to be included in the YCCSA Summer Scholarships Programme for 2020.

It is the purpose of the YCCSA Summer School that any projects submitted are novel and interdisciplinary in nature.

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<th>Date</th>
<th>12/01/2020</th>
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| **Supervisors’ Names with Departments / Affiliation and Contact Email** | **Brains**: David Halliday (EE), Simon O’Keefe (CS)  
**Swarms**: Phil Garnett (Mgmt), Elva Robinson (Bio)  
**Robots**: James Stovold (CS), Martin Trefzer (EE)  
[David Halliday@york.ac.uk](mailto:david.halliday@york.ac.uk)  
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[Martin Trefzer@york.ac.uk](mailto:martin.trefzer@york.ac.uk) |
| **Group Project Title** | BioComp: where bio-inspired social network dynamics, brains and robots meet |
| **Project Description** | Complex state-of-the-art technology artefacts (computers) or processes (workflows) require an enormous, strongly hierarchical bottom-up design effort. Such systems are often highly specialised to make them efficient, which makes them high maintenance, inflexible and fragile. In contrast, there are many examples of large complex systems in Nature that exhibit scalability, collective co-ordination, robustness and adaptation as an inherent emergent property. From the molecular interactions of gene regulatory networks driving development of multi-cellular structures [1,2], to the chemical signalling between bacteria in a Protozoa society [3] and complex systematics of colonial organisms in a Hydrozoa consisting of many sub-organisms [4]. For example, in ant colonies, individual workers have limited memory and decision-making capabilities [5,6] yet when working together at a huge scale exhibit many non-centralised features including self-organisation, self-optimisation and robustness. In the human brain, networks of interacting units (neurons) are able to co-ordinate spatial-temporal interactions in electrical activity [7], facilitating cognitive computations.

This project will study bio-inspired models of dynamical systems from different perspectives – from living organs to living organisations –, with an overarching focus of understanding how dynamical systems behave when interacting in different circumstances. It is anticipated that a cohort of three summer school students will work together on this project, each specialising in one of the three corner topics: brains, swarms and robots.

The goal of this project is to develop models of neural networks, representing biology’s solution of local interactions embodied in organisms (student 1: brains); chemical signalling and behavioural (social) interactions, forming distributed networks between organisms (student 2: swarms); and apply these principles to demonstrate emerging behaviours in a robotic swarm (student 3: robots).
All project components are strongly interlinked, insights and work need to be shared for cross-pollination to occur and for the overall project to thrive. But each student has a part to work on independently and to call their own.

Student One (main discipline)  
**Brains:** Maths / Physics / EE

**Required Skills/Criteria**  
Programming skills and knowledge of Matlab or Python, interest in neural networks and dynamical systems.

Student Two (main discipline)  
**Swarms:** Biology / Sociology

**Required Skills/Criteria**  
Knowledge of agent-based models and dynamical systems, interest in bio-inspired systems modelling.

Student Three (main discipline)  
**Robots:** CS / EE

**Required Skills/Criteria**  
Familiarity with robots and simulators, embedded programming skills, interest in bio-inspired models and hardware.

**Supervision and Collaboration Arrangements**  
The supervisor team and their range of expertise reflect the overall project ideas. All supervisors will be available informally throughout the summer period (occasionally by skype meetings) and regular weekly group meetings will be scheduled.

**Project Dates**  
The summer school runs for 9 weeks, starting on Monday, 13 July 2020 and finishing on Friday, 11 September 2020.

**Other Information**  
n/a

**References**


When complete, please email the form to sarah.christmas@york.ac.uk