Heterotic Computing Theory

Unconventional computing exploits unconventional material substrates within which to perform computation. Practical unconventional computing devices can comprise multiple unconventional substrates, each performing the part of the overall computation that it does best. For example, a bacterial system may be combined with an optical system to solve the `wiring problem' of composing components, or a reaction-diffusion chemical system may be combined with a micro-fluidic droplet system to provide a range of contexts for the reactions. In even the simplest cases, an unconventional substrate is often combined with a conventional digital computer, for example carbon nanotubes in an evolutionary algorithm loop controlled by a PC.

We have developed a computational framework called *Heterotic computing* (named from the term in genetics meaning 'hybrid vigour'), which can be used to extend a theory of unconventional computing to such multiple substrates.

The goal of this PhD research is to **formalise the theory of heterotic computing**, in order to provide a means for quantifying the computation done in each substrate layer, in the various transduction processes needed to convert data representations, and in the setup and readout processes. (Many proposed hypercomputational devices neglect consideration of many of these aspects, mis-concluding that the devices are more computationally powerful than they actually are, thus demonstrating the importance of accounting for all computational resources.) Additionally, the formalisation will provide a rigorous approach for designing such systems, and evaluating the computational capacity of novel substrates.

This PhD research will be cosupervised by
Prof Susan Stepney (Dept Computer Science; YCCSA)
Dr Angelika Sebald (Dept Chemistry; YCCSA)