Modelling animal perception of camouflaged prey using artificial observers

Supervisory team:
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Host institution: University of Bristol

Project description:

Animals display a remarkable diversity of colouration, a topic that has fascinated scientists since Darwin and Wallace. Despite decades of research, significant gaps remain in understanding why certain animals look like the way they do. Most studies have focused on narrowing down the functions of particular strategies, such as disruptive coloration, which helps conceal animals by breaking up their shape. Others have explored general correlations between colouration and ecology, like the prevalence of spots or stripes in more closed environments. The core challenge of understanding colouration is complexity: animals exist in intricate ecosystems where they interact with various observers, including predators, prey, potential mates and competitors. Modelling optimal colouration for concealment or signalling is hard due to the sheer number of variables, including possible colours, patterns, and shapes of animals as well as the environment they inhabit. Studying these systems with biological observers is constrained by time, complexity, and ethical considerations.

Advancements in machine learning now make it possible to create artificial agents mimicking biological behaviour. Deep neural networks have demonstrated success in target detection across various contexts, but these tasks are typically performed without integrating biological vision, i.e. networks determine the best way to detect targets limited only by their mathematical complexity rather than biological input. However, we have previously shown that networks can model human performance in detecting camouflaged targets, effectively replicating aspects of human vision for certain tasks.

We envisage that this PhD will expand on this approach in two ways. First, models will be created with both the targets and their backgrounds included, enabling artificial observers to process the complete visual scene rather than focusing solely on the target. Second, the project will extend the methodology to non-human animals with different visual systems, starting with fish (sticklebacks, Gasterosteidae), then domestic chickens (Gallus domesticus), with an option to include rats (Rattus norvegicus).

The project will establish you as an expert of visual ecology at the intersection of sensory biology and machine learning. You will acquire transferable skills in programming (Python / R / Matlab), animal behaviour, and mathematical modelling, and will join a dynamic, fun, and interdisciplinary team with opportunities to tailor your own research plans.

Our aim as the SWBio DTP is to support students from a range of backgrounds and circumstances. Where needed, we will work with you to take into consideration reasonable project adaptations (for example to support caring responsibilities, disabilities, other significant personal circumstances) as well as flexible working and part-time study requests, to enable greater access to a PhD. All our supervisors support us with this aim, so please feel comfortable in discussing further with the listed PhD project supervisor to see what is feasible.