

The octopus and the artificial intelligence

A part of 'Octopus Skin and Terrain Patterns', 2020-21. Orphan Drift ISCRI art team. Blender 3D work by Maggie Roberts and Megan Bagshaw, chromatophore pattern simulation coded by Duncan Paterson.

The ecosystem crisis and current developments in artificial intelligence are raising ethical and philosophical questions about human primacy. A cross-disciplinary project is seeking ways of rethinking communication with other life forms, whether organic, synthetic, or combinations of both. By **Stephanie Moran** and **Maggie Roberts**.

Introduction

A novel project combining art, technology, and science is examining the idea of communication, in this case between human and non-human life forms. The project

builds on new developments in three research areas: octopus cognition, animal communication, and artificial intelligence (AI). After their exhibition, 'If AI Were Cephalopod'¹, exploring the octopus as an alternative model for future artificial intelligence (a computer system capable of learning), artist collective Orphan Drift wondered whether octopus intelligence could actually be the basis for a digital AI.

ISCRI is the resulting exploratory artistic, scientific and technological collaboration between artist Maggie Roberts and Orphan Drift, and digital research agency Etic Lab, that will create an AI programmed by an octopus.

In an iterative process, an AI will learn from an octopus in its environment, and be programmed by the octopus's responses to artworks made for it. Recent animal research breakthroughs offer insights into non-human communication, and the application of machine learning (ML) to process and analyse vast quantities of data is opening up new avenues of enquiry. The octopus's distributed

cognition—understanding its world via nine 'brains'—offers insights into a very different consciousness to our own; one that is both individual and collective at the same time.

Stephanie Moran, PhD student at Plymouth and Associate Partner at Etic Lab says, 'In this novel project we will be making clumsy attempts at octopus communication, using aesthetic forms rather than language or mathematics as provocations or invitations to respond'. Although informed by extensive research into octopus cognition and behaviour, and for Maggie, by much time spent underwater in their environment and working with an interspecies communicator, ISCRI is at pains to point out that this is very much an exploratory project. ISCRI wants to keep ideas about what communication might involve open-ended. Stephanie explains, 'The advantages of a speculative approach include freedom from convention and pre-defined outcomes. We are not trying to prove something in the field of marine biology, but seeing what emerges.' She adds, 'We will use as many different sensors as we can so that the AI draws on the widest range of information available. We accept the possibility that the octopus may not recognize our attempts at communication

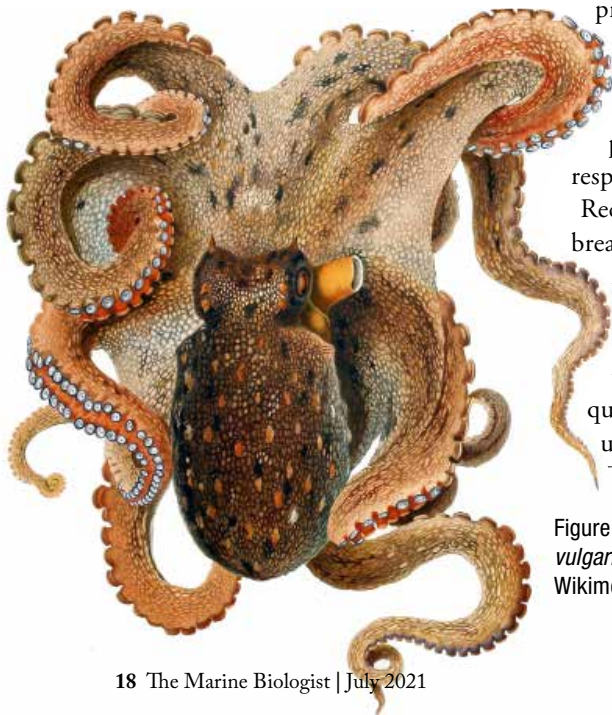


Figure 1. The common octopus, *Octopus vulgaris*. Image: H. Zell / CC BY-SA 3.0 / via Wikimedia Commons.

Box 1: Decentring human experience

Recent advances in animal communication research enabled by machine learning are challenging human-based assumptions about other species' intelligence and consciousness. As primatologist Frans de Waal points out, if we set up experiments based on human capacities, values and cognitive and perceptual apparatus, then we are really only testing other animals for human-like qualities.

ISCRI sees itself as part of wider cross-disciplinary efforts to destabilize a western mentality that solipsistically places human values and survival above all other species. There have been evolutionary reasons to do so, and we have as a species been wildly over-successful; but does our equally evolved moral sense oblige us to now consider the survival of other species — if not for altruistic reasons, at least in the interests of maintaining a quality of

life and because of our capacity for aesthetic appreciation?

A key aspect of the project is the attempt to dismantle human biases and assumptions in order to view the novel cephalopod/AI 'system' without preconceptions. The importance of the unknown is acknowledged, as is the recognition of ourselves — both the ISCRI team and visitors to the art exhibition — as part of an experiment in which we are changed in some way.

or may refuse to engage, and in either of those eventualities, we will also learn something.'

The team aims to show the project via a high-profile touring art exhibition. Stephanie says, 'We will use the AI and the learning from this experiment to produce an immersive exhibition where participants can experience, to some extent, kinds of consciousness alien to ours: octopus-like, non-human aesthetics based on the eight-limbed distributed cognition of an octopus. The octopus AI will mediate between the audience and video stream, responding to the audience as if they were an octopus.' Maggie adds, 'We are hoping that the AI will generate a video stream that in some way reproduces octopus-like behaviour that might help us imagine its lifeworld, and a relationship unknowable to us between these two kinds of distributed consciousness.'

The octopus and the AI

Current octopus cognition research is fundamentally changing our understanding of how octopuses perceive the world, from a better understanding of their chemotactile sense (van Giesen *et al.*, 2020) — a smell-taste-touch sense without a direct human equivalent — to the ways they may sense light through their skin and see the plane of polarization of light rather than colour.

The arena in which the attempts

to communicate will take place is a mesocosm² created for a common octopus (*Octopus vulgaris* - see Figs. 2 and 3). This species is adaptable

and individuals are likely to be curious. ISCRI has consulted with the MBA's aquarist Alix Harvey and with Graziano Fiorito of the Stazione

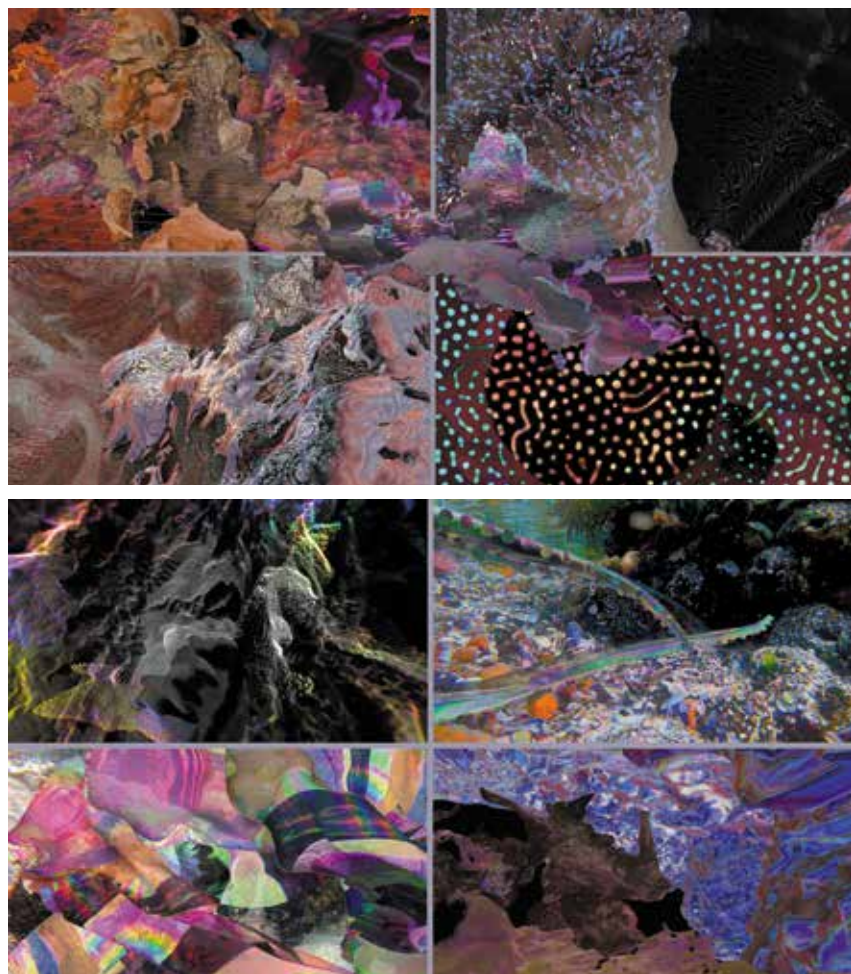


Figure 2 a) (Top) 'Octopus Skin and Terrain Patterns', 2020-21. Orphan Drift ISCRI art team. Blender 3D work by Maggie Roberts and Megan Bagshaw, chromatophore pattern simulation coded by Duncan Paterson. b) (Bottom) 'Polarised Light Vision', 2020-21. Orphan Drift ISCRI art team. Underwater filming, Maggie Roberts, Blender 3D work by Maggie Roberts and Megan Bagshaw, LIDAR scan animation by Jason Stapleton.

1 <https://bit.ly/2QO2PIW>



Figure 3. Representation of play objects and audio-visual artworks in the mesocosm. On an arm with two out-facing circular video screens, a close-up of a crab pincer in seagrass on one screen morphs on the other screen into an animated 3D object making unfamiliar moves. The octopus moves to examine the phenomenon with two arms then four. Its mantle expands, and it changes colour from white to orange.

Zoologica Napoli to ensure ethical octopus husbandry and to provide an environment as close to natural as possible, with prey introduced into the habitat from a second tank. The mesocosm will contain play objects and audio-visual artworks (provocations), and an array of sensors in the water (including

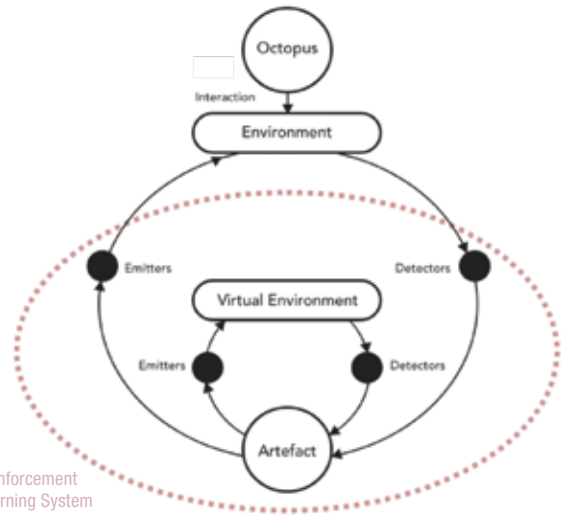
infrared, full spectrum colour, motion and chemical sensors) to detect the responses in the whole environment (see Figs 3 and 4). The data collected will be parsed by a non-goal-oriented type of machine learning algorithm called reinforcement learning (RL) which enables patterns to emerge rather than deciding in

advance what is being sought.

The algorithm and artworks for an octopus have been designed through our understanding of cephalopod cognition. However, this is where human intervention recedes, as the learning of the system depends on the feedback it receives from the octopus.

The ISCRI project has completed a two-year research phase and is reaching the end of a further one-year prototyping phase. Prototyping includes the initial visual material and objects for the octopus to respond to (see images), the reinforcement learning algorithm and its set-up with the sensors in an underwater environment. ISCRI is working with a major UK art institution, the Serpentine Gallery's Creative AI Lab, and is in conversation with a number of other international galleries towards a touring exhibition in 2024. It is currently seeking further funding and partners to enable the next phase: working with an octopus.

Stephanie Moran (stephanie.moran@plymouth.ac.uk) PhD student at Plymouth and Associate Partner at Etic Lab, and Maggie Roberts <https://www.orphandriftarchive.com/>



Reinforcement Learning System

Figure 4. 'Emitters' are the artworks; 'Detectors' are the AV recordings, and temperature, light level, spectrum, water pressure and chemical sensors. These will measure changes in the environment and an algorithm will learn from patterns in all of the sensor data collected, including the octopus's responses to the artworks. It (AI) will in turn modulate the video stream.

Box 2: What do we mean by 'aesthetics'?

Aesthetics is the capacity for taking pleasure or displeasure in an object or event, or engaging in activities that produce or seek sensory stimulation. Aesthetic behaviour can be seen as a mode of cognition, a way of engaging with the world that extends beyond practical motivations such as the search for food or a mate. Non-human animals might therefore display aesthetic behaviours or engage in aesthetic relationships, and octopuses seem good models for non-human aesthetic behaviour as they often appear to engage with the world in ways that extend beyond what is required for their individual survival or species reproduction.

The way we are using non-human aesthetics more loosely here is a way of speaking about the different pleasures other species seek and draw from their lifeworlds based on their differently embodied cognitive realities; this is partly about finding a means of non-linguistic communication, as initiated by the artwork and mediated by the AI; and partly about communicating that exchange to other humans, *embedded in an aesthetic form*.

We began to think about non-human aesthetics as non-anthropomorphic ways to stimulate an octopus's curiosity. Maggie has learnt to free dive and has also worked with an interspecies communicator over the past couple of years, in order to experience the octopus's habitat and to imagine into the perception of an octopus in its ocean environment.

2 Mesocosm: a body of water with close-to-natural conditions, in which environmental factors can be realistically manipulated.