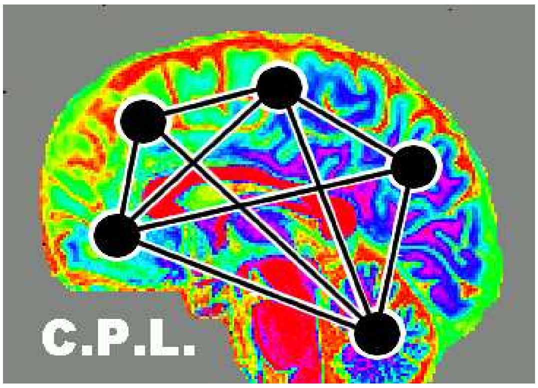
IT Services

Case Study

BlueBEAR provides a substantial computing resource that properly supports the research work of research staff and students at Birmingham. It provides a cost effective facility that optimises the effectiveness of research and ensures the University continues to be a world-class academic learning and research environment.

Co-evolutionary body-brain couplings in models of simple undulatory animals



Challenges

Understanding behavioural processes in primitive animals has abundantly focused on the modelling of undulatory creatures, for example, eels or lamprey. Such models typically focus on bio-physical processes coordinated by either a hard-coded or evolved neural control system with a fitness function often based on the e-ciency or speed of swimming. Whilst all of these models have been met with success, many of them fail to address exactly how a multitude of behavioural primitives, in the case here, swimming forwards and turning left or right can come about as a response to a carefully attuned brain / body coupling. Moreover the neural systems of many of these models are overly complex making those that have evolved extremely di-cult to analyse.

Background

To more fully address the above challenges, a model of an eel-like animal has been developed. The creature's body segmentation characteristics together with the architectural and computational properties of a spiking neural network are coevolved until the creature is able to swim towards a target. This target can occupy multiple locations meaning that the creature needs to incorporate several motor primitives including forwards locomotion and turning left or right. Motor primitives endow the creature with the potential to swim towards any point in three dimensional space, however, depending on its body morphology characteristics and its nervous system, it may be more or less constrained in its locomotive capacity. The framework is ideal when it comes to investigating the effect of a coupled brain-body system on behavioural process.

Tentative results

Results have indicated that effective control comes about due to both an attuned body morphology and an optimal nervous system architecture. Both body and nervous system become coupled together and the movement workload becomes as much about the passive movements of the creature morphology as the active dynamics (i.e., motor output) of the computational nervous system. Furthermore, when certain aspects of the creature's body morphology are constrained, the nervous system architecture emerges to have much greater control over the creature's motor system. This control is however lessened when the body plan is allowed to become optimized during the evolutionary process.

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Product Used
Custom developed simulation software (C++, MPI),
Neuro Simulation Technology (NEST)

Funding
Honda Research Institute Europe

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