



## **School of Computing, Engineering, and the Built Environment Edinburgh Napier University**

### **PHD STUDENT PROJECT**

#### **Application instructions:**

Detailed instructions are available at :

<https://www.napier.ac.uk/research-and-innovation/doctoral-college/how-to-apply>

*Prospective candidates are encouraged to contact the Director of Studies (see details below) to discuss the project and their suitability for it.*

### **Project details**

#### **Supervisory Team:**

- DIRECTOR OF STUDY: Prof. Emma Hart (Email: [e.hart@napier.ac.uk](mailto:e.hart@napier.ac.uk))
- 2<sup>ND</sup> SUPERVISOR: Dr Leni Le Goff

**Subject Group:** Computer Science

**Research Areas:** Computer Science (AI, ML), Engineering

**Project Title:** Evolutionary Robotics

#### **Project description:**

The project will explore optimisation and learning techniques in the context of evolutionary robotics. Possible avenues of research include the co-evolution of body and control to produce robots that are specified to particular environments and tasks, and are capable of adapting to new environments. Alternative projects might focus on learning mechanisms only to refine behaviour on the fly (e.g, through evolution, reinforcement learning, machine-learning) in response to task or environmental changes, with a specific focus on learning diverse repertoires. These techniques could also be extended to cover swarms of robots in addition to single robots. Projects can be conducted in simulation only or take advantage of our robotics laboratory to conduct experiments on physical robots

**References:**

Hart, E., & Le Goff, L. K. (2022). Artificial evolution of robot bodies and control: on the interaction between evolution, learning and culture. *Philosophical Transactions of the Royal Society B*, 377(1843), 20210117.

Arza, Etor, Leni K. Le Goff, and Emma Hart. "Generalized Early Stopping in Evolutionary Direct Policy Search." *ACM Transactions on Evolutionary Learning* 4.3 (2024): 1-28.

Thomson, S. L., Le Goff, L., Hart, E., & Buchanan, E. (2024, July). Understanding fitness landscapes in morpho-evolution via local optima networks. In *Proceedings of the Genetic and Evolutionary Computation Conference* (pp. 114-123).

Li, W., Buchanan, E., Le Goff, L. K., Hart, E., Hale, M. F., De Carlo, M., ... & Tyrrell, A. M. (2023). Evaluation of frameworks that combine evolution and learning to design robots in complex morphological spaces. *IEEE Transactions on Evolutionary Computation*, 211.

Le Goff, L. K., Buchanan, E., Hart, E., Eiben, A. E., Li, W., De Carlo, M., ... & Tyrrell, A. M. (2022). Morpho evolution with learning using a controller archive as an inheritance mechanism. *IEEE Transactions on Cognitive and Developmental Systems*, 15(2), 507-517.

## **Candidate characteristics**

**Education:**

A first degree (a minimum 2:1) in Computer Science, Mathematics, Engineering

**Subject knowledge:**

Machine-Learning, Optimisation

**Essential attributes:**

- Excellent programming skills (C++ and/or Python)
- Excellent data-analysis skills
- Basic statistics
- Strongly motivated and able to work independently
- Good time management

**Desirable attributes:**

- Some experience in robotics
- Experience of optimisation techniques
- Experience in evolutionary computation