Swimming in sand: modelling the mechanics of locomotion through granular materials

Prof Antoinette Tordesillas and Dr Jennifer Flegg

Force chains are a defining aspect of force transmission in granular materials. Knowledge of how moving bodies navigate and adapt their shape in response to force chains is thus essential to achieving optimal mobility in granular media environments. In this project, you will study the effect of body shape on the locomotion of slender, elongated bodies. The aim will be to cast light on how moving bodies adapt their shape to endogenous force chain structures in order to achieve optimal penetration and body propulsion in granular terrains. You will develop a mathematical model of the forces experienced by the body and implement a computational model to quantify the trade-off between decisions at the local and global scales. The mathematical modelling approach will be compared to experimental observations available on the locomotion of the Australian sand skink, *Lerista* (see Figure 1(a)).

Mathematical models that can reliably predict the reaction forces in granular-solid interaction systems have far-reaching benefits beyond fundamental research including the design and control of ground robots for operations in hazardous environments (see Figure 1(b)).

(a) (b)

Figure 1: (a) The *Lerista* is a subterranean sand swimming species whose limbs are believed to play little or no role in locomotion. (b) Snake robots help search for survivors in collapsed buildings.

Prerequisite skills: Good coding skills (MATLAB or equivalent), understanding of mechanics desirable